

AERIAL ROPEWAY TRANSIT AS A CATALYST FOR SUSTAINABLE URBAN  
GROWTH IN HONOLULU

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# Abstract

Oahu's transportation infrastructure is one of the most vital components of its built environment, providing passage for social, cultural, and economic exchange. However, current patterns of urbanization have led to an auto-centric landscape, limiting the development of people-centered communities. And, as both population and road congestion have continued to swell, the existing transportation network has struggled to provide fluid and direct access to critical urban nodes, further leading O'ahu towards unsustainable growth.

Current mitigation strategies propose to strengthen Oahu's transit network by transitioning people from their automobiles to a more transit-oriented lifestyle by way of a new rail transit system and transit oriented development policy. While the rail project does have the potential to positively redirect Oahu's urban development, its existing route terminates at Ala Moana Shopping Center, leaving several critical urban locations disconnected from the project's sustainable development strategies. It has been projected that the future Ala Moana Rail Station will have 22,610 people exiting and entering the station daily—a majority of whom are expected to travel eastward of Ala Moana. In addressing the disconnection, this research proposes to integrate aerial ropeway transit as a new mode of public transportation, supporting more livable, connected communities beyond the rail terminus.

These advantages include lower operating costs, smaller construction footprints, greater route flexibility, and a more engaging rider experience. A literature review, based on O'ahu's sustainable development and transportation strategies, is used to gain thorough understanding of the relationships between transportation and development, in addition to constructing a framework that proposes appropriate route alignments connecting Waikiki, UH Manoa, and Kaimuki to the Ala Moana Rail Terminal. Furthermore, a site analysis and various case studies are used to further support the system's potential to catalyze sustainable growth by increasing mobility and access between urban destinations.

Universally, ART is still a relatively new method for providing

transportation within a city, especially within the United States. And, while its implementation faces certain physical and social challenges within Honolulu's urban environment, this thesis maintains the position that solutions to existing urban design issues can be found through exploring unconventional systems of thinking.



# Chapter 1: Introduction

## 1.1 Background

The island of O‘ahu is currently experiencing a period of transformation. As population steadily increases, construction of new development and infrastructure are underway in order to provide more social and economic opportunities for both its residents and visitors. However, this rapid growth can cause a number of issues. Urban development without sufficient planning frequently results in social, spatial, and economic suppression due to issues such as traffic congestion, indirect roadway networks, and other urban boundaries. These issues cause a lack of mobility and access needed to allow the facilitation of social and economic growth, both integral to a thriving urban environment. As Honolulu’s residents explore strategies for improvement, communities have looked to other examples of successful communities and have identified that walkable, mixed use, and well connected neighborhoods are a few of the many design principles that can potentially provide a higher quality of living. Planners, architects, and urban designers are each well-informed to the fact that multi-modal transportation infrastructure is one of the most critical aspects in establishing strong relationships between people and their surrounding urban landscape. Pedestrian, bicycle, vehicle, and rail networks help to lay the framework for urban development, as they collectively work together in shaping the many different components that go into building advantageous municipalities. Therefore, it is vital that this transportation network supports urban growth in a manner that improves sense of place and quality of life for both the residents and visitors on O‘ahu.

The city of Honolulu’s new rail guideway aims to connect residential and employment centers beginning in West O‘ahu, and terminating at the Ala Moana Shopping Center near downtown Honolulu. The overall goals are to promote a more connected urban core by increasing access, reliability, and mobility to new and planned development. Together with rail, the city is also implementing a Transit Oriented Development (TOD) plan, otherwise known as a model of planning that specifically favors the development of high density, mixed-use, walkable neighborhoods centered around transportation hubs.

However, residents and visitors beyond the rail terminus do not benefit from Honolulu's new planning and infrastructure, leaving employment, educational, and recreation destinations disconnected. While future plans propose extensions beyond Ala Moana, implementing heavy rail infrastructure throughout communities beyond the station will be difficult and challenging, as already seen in the project's early construction phases.<sup>1</sup>

This thesis proposes to explore the potential of integrating aerial ropeway transit (ART), i.e. an aerial gondola system, as an alternative mode of public transportation to better support economic revitalization and development growth beyond the new rail guideway in Ala Moana. Aerial cable cars have long been utilized as a means of transport over some of the globe's most challenging terrain to move everything from people to building materials. Through many years of development, the aerial gondola has seen advances in speed and safety, which have allowed the system to be recognized as both an attractive and efficient mode of urban public transportation. While most commonly seen in mountainous ski resorts, the use of an aerial gondola as a means of urban public transit is commonly perceived by the public as eccentric. However, the system has been successfully utilized in many parts of the world to both socially and economically improve communities affected by many of these emerging development issues. Although ART has many benefits, as well as various challenges regarding its implementation, this transportation system has the ability to support Honolulu's development plan to focus growth and population increase within its urban core, and can provide Honolulu with a unique method for improving the quality of life while simultaneously fostering sustainable growth.

#### *Directions on O'ahu*

- The 'Ewa direction is *West*
- The Diamond Head direction is *East*
- The mauka direction is toward the mountains
- The makai direction is toward the sea

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<sup>1</sup> CallisonRTKL, Belt Collins Hawai'i, Fehr & Peers, Keyser Marston Associates, "Ala Moana Neighborhood Transit-Oriented Development Plan," (Final Plan) (Honolulu: The City and County of Honolulu, 2016), [http://www.honolulu.gov/rep/site/dppto/alamoana\\_docs/Ala\\_Moana\\_-\\_Draft\\_Final\\_TOD\\_Plan\\_Report\\_042516web.pdf](http://www.honolulu.gov/rep/site/dppto/alamoana_docs/Ala_Moana_-_Draft_Final_TOD_Plan_Report_042516web.pdf).

### *O‘ahu’s Development Plans*

As a number of complex variables and relationships will be influenced by new transit integration, it is easy to unintentionally affect the city in a way that negatively impacts the quality of life for both residents and visitors. Therefore, implementing new development strategies as well as transportation infrastructure within a city, especially at a larger scale, requires a considerable amount of planning and research, primarily through collaboration with designers, policy makers, and community stakeholders. There are currently several plans already in existence that have been formulated through extensive public review by diverse sectors—including government, institutional, and non-profit agencies—which address growth and development strategies at both regional and neighborhood scales. These policies aim to drive Honolulu towards positive growth socially, economically, and environmentally. As this research proposes the construction of an unconventional transportation infrastructure, it is profoundly important that implementation of ART is supported by policy foundations outlined within community plans, including the *General Plan*, *Primary Urban Center Development Plan*, *O‘ahu’s Regional Transportation Plan*, the newly proposed *Transit Oriented Development Strategies*, and other similarly focused neighborhood plans.

While these documents describe a variety of growth policies in both broader and more specific terms, their strategic recommendations for transportation and development policy are notably consistent. Based on the visions, goals, strategies, and tactics described for each plan, several major principles regarding transportation and development emerge: connecting transportation to dense and diverse land use, cultivating vibrant neighborhood centers, supporting the transportation hierarchy, and reducing reliance on automobiles.<sup>2 3</sup>

In order to support higher levels of access and mobility, public transportation infrastructure needs to be integrated within dense and diverse development. These environments include a mixture of residential, business, and educational, as well as other

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<sup>2</sup> Bryce Tupper, "Proposed Burnaby Mountain Gondola Transit Project," UniverCity On Burnaby Mountain, April 22, 2009, 5.

<sup>3</sup> Department of Planning and Permitting, "Primary Urban Center Development Plan," (Honolulu: The City and County of Honolulu, 2004), [https://www.honolulu.gov/rep/site/ocs/roh/SCP\\_DP\\_PrimaryUrbanCenter.pdf](https://www.honolulu.gov/rep/site/ocs/roh/SCP_DP_PrimaryUrbanCenter.pdf).

amenities that are within close proximity to one another. Furthermore, allowing such close proximity of mixed-use programs allows people to easily and quickly travel between work, live, or play destinations either by walking or bicycling; thus eliminating heavy reliance on vehicles, and in turn reducing long-term investment in automobile infrastructure. When people need to travel across longer distances, denser communities create a much larger market for public transit users. High quality transit infrastructure has the potential to provide fast, frequent, convenient, and pleasant commutes. If a community's public transit system can provide quality incentives such as these, transit ridership can potentially increase, helping to further sustain as well as re-invest in efficient and attractive modes of transit. <sup>4</sup>

Supporting the hierarchy of transportation modes is another fundamental underlying principle that O'ahu uses to guide growth. This hierarchy not only establishes priority for the different modes of transportation throughout the entire city, but it is also used as a guide for small-scale neighborhood and town square decision making. Furthermore, the hierarchy emphasizes the priority of inexpensive and environmentally friendly modes of transportation, including walking and bicycling, followed by public transit; and private automobile use ranks the very lowest out of all modes of transportation. While the hierarchy does not suggest bicycle lanes and sidewalks should receive more money for infrastructure, it does suggest that improvements for transportation modes lower on the hierarchy should not negatively affect pedestrian priorities. <sup>5</sup>

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<sup>4</sup> CallisonRTKL, Belt Collins Hawai'i, Fehr & Peers, Keyser Marston Associates, "Ala Moana Neighborhood Transit-Oriented Development Plan," Final Plan. 3.

<sup>5</sup> Bryce Tupper. "Proposed Burnaby Mountain Gondola Transit Project," 6.

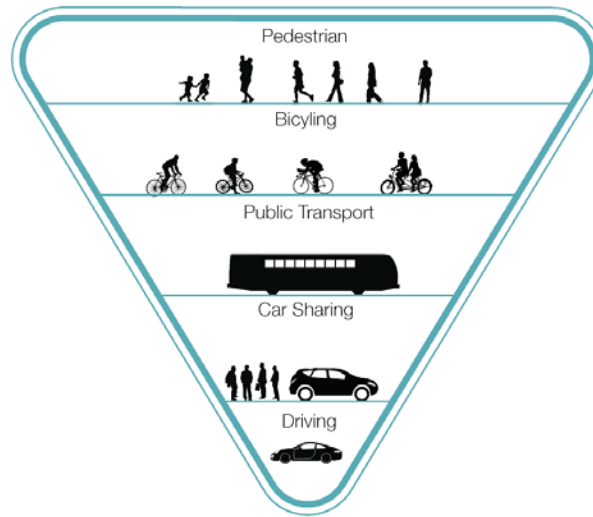


Figure 1: Hierarchy Diagram

Source: Made by Author

It has long been known that the increasing use and ownership of automobiles has led to crippling traffic around the island. The roadway infrastructure designed to support automobiles failed to predict the volume and intensity of drivers traveling to and from work each day. As a result, commute times have drastically increased, causing drivers to spend a significant portion of their day inside their car. Commuter patterns have also shown that people are adjusting their daily lives around peak hours of congestion, mainly in the morning and early evening.<sup>6</sup>

In support of a livelier, mixed-use community, reducing the reliance on driving would also reduce the reliance on parking. Because every automobile arriving at a destination needs a parking stall, a significant amount of parking space is needed to support the high volume of vehicles arriving at any one destination. While parking is a necessary component for supporting a balanced multimodal transportation network, providing large amounts of on-street and off-street parking reduces development opportunity for establishing new mixed-use programs, thus weakening the fundamental components for a compact community.<sup>7</sup>

<sup>6</sup> “Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement,” Chapter 3 (Honolulu: The City and County of Honolulu, 2016).

<sup>7</sup> Bryce Tupper. Proposed Burnaby Mountain Gondola Transit Project, 6.

Reducing automobile use was also a strategy for creating a cleaner and more sustainable environment, as noted by many of O‘ahu’s future development goals. As Hawai‘i prides itself on being a leader in environmental sustainability, current policy aims to drastically reduce reliance on fossil fuels and emissions—as both have been linked to global climate impacts. It is estimated that over 80% of all daily commutes on O‘ahu are made by automobiles. As vehicles emit a significant percentage of the total greenhouse gases released into the atmosphere, transitioning commuters away from their private vehicle falls in line with Honolulu’s sustainability goals.<sup>8</sup>

## 1.2 Motivation

### *Role of Transportation*

Transportation is inseparable from the fabric of a city. While it provides pathways between destinations, transportation infrastructure plays a fundamental role in shaping the form and character of neighborhoods and cities around the globe. Transportation networks help to determine access of opportunity for residents by implementing development patterns that influence the cost and convenience of traveling to work, live, and play destinations.

Transportation infrastructure has also helped shape O‘ahu’s neighborhoods and communities. Developed in 1903, electric streetcars were one of the first modes of public transportation that helped to establish roadways between the communities surrounding Honolulu. Approximately 20 miles long, the streetcar network also helped to guide building and public space developments that led to the expansion of social and economic opportunities, and in turn established Honolulu as O‘ahu’s primary urban center. However, roadway development for cars and buses completely replaced electric streetcars. Vehicles allowed individuals faster and more convenient commute times over longer distances, which helped to increase the potential for new development to be constructed at further distances.<sup>9</sup>

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<sup>8</sup> “Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement,” Chapter 3 (Honolulu: The City and County of Honolulu, 2016).

<sup>9</sup> “Waikīkī Regional Circulator Study”, report, Department of Transportation Services (Honolulu, HI: Weslin Consulting Services, 2013), 15-18.

As populations continued to rise with the proliferation of the automobile, the urban environment transformed, further transitioning the city into becoming more automobile oriented. Demand was met with construction of the H-1 Freeway, which allowed people to live much further outside the city of Honolulu. Otherwise known as suburbanization, or sprawl, this low-density expansion caused by a mass migration of the urban population outwards, was driven by many individuals searching for more open space and a higher quality of life outside the city. The automobile allowed people to access cheaper home prices and larger land ownership, while attracting many individuals and families away from the crowded urban center. As a result, massive highways were constructed to support the increased traffic volume. However, this infrastructure has been unable to support increasing automobile ownership. Ironically, the at-grade roadway network constructed to improve mobility and access has also become a barrier to socio-economic growth by favoring automobiles over pedestrians.<sup>10</sup>

#### *HART Transit Line*

To address the emerging disconnections between O‘ahu’s neighborhoods, schools, and employment centers, the City and County of Honolulu proposed to construct a new rapid transit rail system across the main development corridor. While it does not aim to eliminate roadway traffic, the rail is meant to provide transportation priority to people rather than vehicles, and serve a large portion of total daily transportation trips made throughout the island of O‘ahu. Intended to become the transit backbone of the island, the heavy rail guideway aims to create a stronger connection between major residential and employment centers near downtown Honolulu and Ala Moana Shopping Center.<sup>11</sup>

The initial route is proposed to span 20 miles and have 21 stations between major population centers such as East Kapolei, near the University of Hawai‘i’s West O‘ahu Campus; the Leeward Community College; Pearl City; Pearlridge; Aloha Stadium; Salt Lake; Kalihi; Honolulu Community College; downtown Honolulu; Kaka‘ako; and Ala Moana Shopping Center. The rail line is confined by the Wai‘anae and Ko‘olau Mountain

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<sup>10</sup> Ibid.

<sup>11</sup> “Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement,” Chapter 1 (Honolulu: The City and County of Honolulu, 2016), 18-30.





initial route fell short of several destinations, future plans aim to build guideway extensions to reach critical employment and residential centers beyond Ala Moana. Unfortunately, consideration and funding for the project will not likely happen until much later, after the initial route is completed in 2021, leaving several of Honolulu's critical neighborhoods disconnected.<sup>15</sup>

### *Connectivity and Transit Oriented Development (TOD)*

Other cities in the United States have also experienced many of the issues that have arisen from lack of sufficient urban planning. Problems including traffic congestion, segregated neighborhoods, and low economic activity have led local governments to adopt a new policy in order to help support economic and community development and reinvigorate neighborhood culture. This policy, otherwise known as Transit Oriented Development (TOD), is a planning strategy aimed at promoting high-density, mixed-use development municipalities where housing, retail, restaurants and other amenities are all within walking distance of a public transit station. Main strategies for TOD include providing quality public transit, quality pedestrian and bicycling infrastructure, reducing reliance on vehicles, rezoning land for different uses, creating high density housing, and providing adequate public gathering space.<sup>16</sup> Honolulu has observed and studied this approach to development, and the city plans to implement its own TOD strategy alongside the new rail project. Honolulu's TOD strategy is a series of development plans aimed at strengthening urban connectivity and development around each rail station. While each plan is unique and carefully looks at all aspects of its specific site, they all aim to reach the same goals.

Overall, the key to achieving O'ahu's TOD goals for a more livable community, is a strong and well-connected multi-modal transportation system. This includes reinforcing walking, bicycling, and transit networks to support better land use and social inclusion.

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<sup>15</sup> Ibid.

<sup>16</sup> Naomi Cytron, "The Role of Transportation Planning and Policy in Shaping Communities", Community Investments 22, no. 2 (2010): 3-6, [http://www.frbsf.org/community-development/files/N\\_Cytron1.pdf](http://www.frbsf.org/community-development/files/N_Cytron1.pdf).

### *Greater Neighborhood Potential*

While the majority of O‘ahu’s residents live and work in areas between West O‘ahu and Downtown Honolulu, a significant portion of Honolulu’s economic center lies just beyond the final rail terminus. Based on site assessments, three locations were determined to be important economic and social centers past the Ala Moana Station. Waikīkī, UH Mānoa, and Kaimukī-Wai‘alae were each identified as major urban destinations that currently possess aspects vital to a well-connected urban environment. Such aspects include having large residential populations, being major centers of employment, having nearby educational institutions, and attracting large volumes of people from surrounding neighborhoods—including areas ‘Ewa of the Ala Moana Station. Overall, these neighborhoods were seen as locations that could reach a greater potential with the inclusion of a strategic development policy and a more prominent, higher quality transportation system.

### 1.3 ART Benefits at a Glance

While frequently absent from the discourse of proposed public transit, the benefits of integrating an urban gondola system have proven to fill a role beyond just that of an eccentric method of promoting tourism. Cities with roadway congestion have used aerial systems to move thousands of people per hour through dense environments, which sometimes proved quicker than an automobile in an area with heavy traffic and/or limited parking. Because long wait times for other transportation systems are undesirable, the benefits of the gondola are more attractive, as the system has quicker departures due to the continuous movement of its looping cable cars. And, depending on the destination, aerial transit commute times are shorter because their routes traverse above roadways and sidewalks, whose paths are constantly interrupted by traffic signals and public right-of-ways.<sup>17</sup>

In addition to these advantages, communities with limited funds conceivably stand

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<sup>17</sup> Gabrielle Gurley, "D.C., Northern Virginia Go For Gondolas: The Answer to Urban Congestion?," *The American Prospect*, February 26, 2016, , accessed September 21, 2016, <http://prospect.org/article/dc-northern-virginia-go-gondolas-answer-urban-congestion>.

to benefit from the system's cost efficiency, as it requires less construction of heavy infrastructure and utilizes high-reaching cables and towers with less underlying land development. Compared to a heavy rail system, few structural columns are needed for support, as the system is able to span up to three kilometers between towers depending on the system technology and the site<sup>18</sup>. Furthermore, the overall construction of ART requires less time since stations and towers tend to be smaller and cheaper. And, once they are constructed, the cable and cabins can be installed relatively quickly.<sup>19</sup>

One of the more intriguing arguments for aerial transit is that it also provides a memorable transit experience. As an elevated system, the user is no longer restricted to ground level movement among cars and buses. Instead, the path lies above the tree line providing individuals with a unique perspective of Hawai'i's urban and geographical landscape that isn't seen on a daily basis. With recent community interest in creating stronger *Mauka to Makai* connections, an aerial gondola system could potentially provide both mountain and ocean views, as well as physical connectivity for passengers. In a book titled *The Image of the City*, the author, Kevin Lynch, discusses the idea that people prefer to know where paths start and end, and that the sense of knowing provides comfort not only to the transit user, but also to the urban dweller; as Lynch states, "clear paths with well-known origins and destinations had stronger identities, helped tie the city together, and gave the observer a sense of his bearings whenever he crossed them."<sup>20</sup> Aerial transit would be able to provide clear connectivity, as both the cables and pathways could be seen from certain vantage points. Furthermore, because of ART's smaller footprint and lighter overhead infrastructure, there would also be less visual obstruction and shadows for the neighborhood's residents below.

Together, these benefits have been proven to greatly enhance the urban area in which they have been implemented, by providing increased access for individuals traveling to work, home, educational, and/or amenity destinations.

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<sup>18</sup> "Honolulu Aerial." Honolulu Aerial. Accessed September 18, 2016, <http://www.honoluluaerial.com/>.

<sup>19</sup> Ibid.

<sup>20</sup> Kevin Lynch, *The Image of the City* (Cambridge, MA: MIT Press, 1960), 54.

### *Problem Statement*

Honolulu's current pattern of urbanization has led to a congested, auto-centric landscape that has limited access and mobility throughout the urban core. In response, Honolulu is currently constructing a rail transportation system in conjunction with new development strategies to help guide the city towards more sustainable growth. However, the rail guideway terminates at Ala Moana Shopping Center leaving critical social and economic centers segregated from the new rail infrastructure. This thesis proposes to implement Aerial Ropeway Transit (ART) as a means to bridge this divide by fostering greater social and economic growth in order to create a more holistic, cohesive, advantageous urban core.

### *Research Aim*

Based on the issues described above, this study explores how the specific advantages of aerial ropeway transit can improve access and mobility within the urban core to encourage more walkable communities and promote social and economic well-being within Honolulu.

- **Economic:** Cost effective transportation, localized land development and spurred economic development.
- **Social:** Social inclusion and accessibility to amenities, education and work opportunities.
- **Environmental:** reduced energy consumption, greenhouse gas emissions, air pollution, and minimal disturbance to urban fabric.

While mobility is a simple concept, its implementation is not. A holistic understanding of urban transport aids in communicating the benefits of gondola technologies to the ART market.

### *Research Questions*

- What are the critical nodes within Honolulu's urban landscape that can benefit from improved transit connectivity?

- What are the advantages of ART systems over traditional rail and bus transit systems?
- How can ART contribute to a more enhanced multi-modal transportation system?
- How can ART support economic development and be a catalyst for neighborhood improvements?
- How will ART be designed to complement the public realm?
- How and for what reasons have ART been implemented in other cities, and what aspects can Honolulu learn from them?
- Finally, is ART appropriate for Honolulu?

## 1.4 Methodology

My research will utilize a combined method approach which includes a literature review, quantitative data, and qualitative analyses to provide a thorough understanding of existing and projected transportation development issues in order to propose a design solution appropriate to Honolulu. To gain a thorough understanding of ART in urban environments, the literature review is conducted to analyze the system's characteristics, its historic development, and current technologies. The literature review will also draw from several of Honolulu's development policy plans to determine the underlying principles that ART can support. Quantitative data on location demographics, development, and transportation statistics will be gathered to determine the need and demand for ART. Finally, qualitative analyses will be used to understand how ART can benefit communities socially and create a more experiential method of travel.

1. A review of literature will be conducted to understand the values and principles of implementing transit and development strategies within urban environments.
2. A technology assessment will be done to determine the most appropriate ART system for Honolulu's environment.
3. A thorough site analysis of population and development projections will be done to determine what destinations will most benefit from implementation.

4. An analysis of current and projected transportation systems, patterns, and behaviors will be done to assess future transit demand, and determine an effective strategy for integrating ART between locations.
5. A collection of relevant case studies, of cities that have successfully implemented ART within their respective urban environments, will be assessed to understand its socio-economic impacts, and determine how to best implement the system in Honolulu.
6. An analysis on the social and experiential impacts will be done to determine potential improvements in the quality of life for residents and visitors.

## 2.0 Aerial Ropeways: History and Development

### 2.1 Historical Development

While aerial ropeway transit is an unconventional proposal for the modern city, the basic form of this system has been used as an effective means of circulating materials and people over challenging geographical terrain throughout history. The simple technology had been used for many different roles such as mining to military use, and has been an important tool for the development of many economies.

The first indication of aerial ropeways dates back to early China, India, and Japan when workers utilized single rope systems spanning between two anchor points to pull themselves across difficult terrain supported by only a harness. Later applications used suspended boxes or baskets pulled by a single rope tied to its front, and was used to carry belongings, individuals, and even livestock. These earlier methods, however, primarily used man and animal power as propulsion and required large amounts of work to operate. Later indications of its advancement continued to be found through the 16th, 17th, and 18th centuries when ropeways in South America and Europe began to use pulleys and tower supports powered by waterwheels and gravity to continuously move carts over larger distances.<sup>21</sup>

Although primitive versions of ropeways were considered a useful means of aerial movement, load capacities and spanning distances were greatly constrained because of the material nature of hand spun rope and its tendency to wear down and break under moderately heavy loads and frequent use. It was not until the development manufacturing of strong wire and cables were the capabilities of aerial ropeways able to further progress. Though the earliest evidence of wire was discovered in Pompeii, it wasn't until 1834 with the development of heavy machinery that strong metal wire was recorded to have been produced and used for cables in an aerial ropeway systems.<sup>22</sup> The carts that were suspended by cables were found to carry much heavier loads and withstand constant, daily operation.

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<sup>21</sup>Ibid.

<sup>22</sup> Edward S. Neumann, "The Past, Present, and Future of Urban Cable Propelled People Movers," *Journal of Advanced Transportation* ATR 33, no. 1 (1999): 56-57, accessed September 25, 2016, doi:10.1002/atr.5670330106.

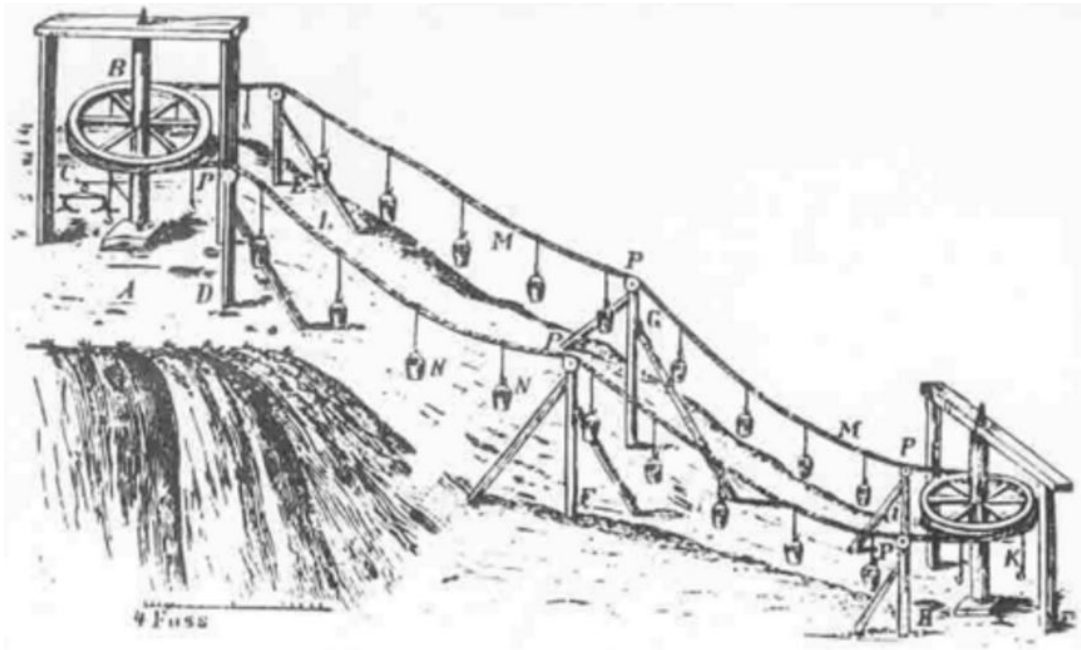


Figure 3. Early Mining Ropeways

Source: Low-Tech Magazine<sup>23</sup>

Other major breakthroughs were the integration of electric engine propulsion and the detachable cart system. The electric engine was especially beneficial because it was able to provide constant propulsion, as operating the system no longer required man or animal power to manually pull the carts. The detachable cart mechanism was also an important technological achievement because it allowed carts or cabins to be detached and reattached for the purpose of loading and unloading while continually running the ropeway.<sup>24</sup> These developments greatly increased the speed, productivity, and flexibility of the system which helped to broaden its use across into new industries beyond mining.

<sup>23</sup>Early Mining Ropeway, digital image, accessed March 22, 2017, <http://www.lowtechmagazine.com/2011/01/aerial-ropeways-automatic-cargo-transport.html>

<sup>24</sup> Kris D. Decker, "Aerial Ropeways" accessed September 24, 2016, <http://www.lowtechmagazine.com>



## 2.2 Systems in the United States

### *Development of Aerial Ropeways in the United States*

Though aerial ropeways had been widely used around the world, they had not been utilized in North America until mining operations began to proliferate in the United States. The first aerial system in the US was constructed in 1861 in Colorado, as a bi-cable arrangement used to transport mining materials and supplies through the Rocky Mountains.<sup>25</sup> While their use continued throughout the mining industry to mostly carry materials, it wasn't until the systems were used to carry people that their potential began to be noticed. The very first system designed for passengers was 1893 in Knoxville, Tennessee. This reversible system used carrier carts that were designed to carry 16 individuals at once, however, it only traversed a short distance across the Tennessee River. Another notable system constructed in the US was the Niagara Falls Tramway, built in 1916 by Leonardo Torres Quevedo. The single-cabin system, which is still in operation today, is unenclosed and has a 35 person carrying capacity, suspended from six support cables that span one kilometer across the Niagara River.<sup>26</sup> This system was important because it was one of the first examples of an aerial ropeway used as a successful tourist attraction, allowing passengers to better engage with the area's stunning geography. Another system which helped to gain attention was the Sunrise Peak Gondola in Colorado. This bi-cable ropeway was constructed in 1906 for individuals seeking to reach the town of Silver Plume from nearby Georgetown. This system spanned 6,600 feet, climbed 3,050 feet, and moved at a speed of 325 feet every minute. The cabins were unenclosed and had a four-person capacity that could carry 120 passengers an hour in each direction. This system was also unique because it was one of the first in the US that utilized multiple passenger carts, in contrast to higher-capacity, single-cabin tramways. It was one of the

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<sup>25</sup> Edward S. Neumann, "The Past, Present, and Future of Urban Cable Propelled People Movers," *Journal of Advanced Transportation* ATR 33, no. 1 (1999): 56-57, accessed September 25, 2016, doi:10.1002/atr.5670330106.

<sup>26</sup> "Whirlpool Aero Car," Niagara Parks, accessed September 28, 2016, <http://www.niagaraparks.com/niagara-falls-attractions/whirlpool-aero-car.html>.

first in the US built for the purpose providing an enriched traveling experience for passengers.<sup>27</sup>

After World War II, the use of passenger aerial ropeways in the US finally began to proliferate; however, they were used mainly on ski slopes. During the early decades of the 20th century, Americans had realized the popularity of alpine skiing areas in Germany, France, Italy, and Switzerland, and decided to develop ski slopes in the United States. The first aerial lift built for skiers was a single cabin tramway in New Hampshire at Cannon Mountain in 1938. Though it allowed recreational skiers to easily travel back to summit, using single-direction tramways were found to be inefficient as passengers needed to wait long periods of time before they were able to re-board the cabin, especially for taller peaks.

To improve passenger efficiency, the use of tramways were replaced with looping chairlifts, which were developed in 1946. Instead of traversing back-and-forth, the looping action allowed a continuous movement of cabins through the system. Simpler and cheaper to construct, the attached chairs were able to continuously flow along the system without stopping. The passenger chairs could move slowly enough for passengers to load without stopping the system, but fast enough so wait time was minimal since each chair arrived every few seconds. Advances in affordability, simplicity, and efficiency was an important because it helped more ropeways to be constructed on ski slopes across the country.

To further improve efficiency and protect passengers from the weather, the detachable, enclosed gondola lift was developed in 1957. Detachability was an incredibly important feature for passenger safety because it allowed approaching gondola cabins to detach from the moving cables and adjust to a slower speed, which allowed passengers to carefully and easily enter the gondola cabin- eliminating the need for a hurried, and potentially dangerous loading process.

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<sup>27</sup> Charles F Dwyer, *Aerial Tramways, Ski Lifts, and Tows*, 1st ed. (Springfield, MA: National Ski Areas Association, 1986).

## Urban Integration

### *New York City, NY*

Although passenger-oriented aerial ropeways were finally beginning to proliferate in the US, their application was primarily constrained within the boundaries of mountain ski resorts and mining. In the urban environment, cars and buses provided the best and only means of transit between destinations. The use of aerial ropeways within the city, especially as an option for urban public transit, was viewed by politicians and planners as merely a recreational transit apparatus for a singular setting and inappropriate for urban circulation. It was not until 1976 that the first aerial system, in the form of a tramway, was constructed within the city. Known as the Roosevelt Island Tramway, this ropeway was constructed to carry passengers 361 meters from Roosevelt Island to Manhattan in New York City. The tramway system utilizes two shuttles, each suspended by four spanning cables. Each shuttle had the carrying capacity of 125 people and could transport approximately 1,500 people per hour at 16 miles per hour in one direction. The Roosevelt Island Tramway was originally constructed to be a temporary urban transit solution for access to Roosevelt Island, however, the enhanced rider experience had made the tramway so popular that in 1989 it was transitioned into a permanent transit station which is still in use today, even though the New York Subway serves as the primary transit method between Roosevelt Island and Manhattan. And, although the tramway continues to be an important aspect in New York's multi-modal transit system, its continued existence relies heavily on its novel character and the spectacular views that it provides mostly to tourists and adventurous residents.<sup>28</sup>

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<sup>28</sup> Alshalalfah, Baha, Amer Shalaby, and Steven Dale, "Experiences with Aerial Ropeway Transportation Systems in the Urban Environment," *Journal of Urban Planning and Development* 140, no. 1 (2014): 04013001. doi:10.1061/(asce)up.1943-5444.0000158, 4-5.



Figure 4: Roosevelt Island Aerial Tramway, New York

Source: Marina Chetner<sup>29</sup>

#### *New Orleans, LA*

The second aerial system built in the United States was known as the Mississippi Aerial River Transit (MART) and was constructed in New Orleans in 1984 at the Louisiana World Exposition. Unlike New York's single cabin aerial tramway, the MART was the United States' first aerial gondola passenger system and utilized fifty-three, six-passenger cars that circulated along a looping haul-cable.<sup>30</sup> Touted as a cheaper alternative transit route with spectacular views, the MART connected the exposition site on the east side of the Mississippi River, 2,200 feet to the central business district in Old Algiers on the west bank of the river. The structural system consisted of two, 360 foot support towers that allowed cabins to traverse 320 feet above the river to provide a unique view of the city. As a rider incentive, passengers had the option to purchase monthly tickets, which even

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<sup>29</sup> "Roosevelt Island Tram", digital image, accessed March 12, 2017, [https://marinachetner.files.wordpress.com/2012/09/dsc\\_0758ps.jpg](https://marinachetner.files.wordpress.com/2012/09/dsc_0758ps.jpg)

<sup>30</sup> Frank Straughan, "1984 World's Fair Gondola (MART)," New Orleans Historical, accessed October 3, 2016, <http://neworleanshistorical.org/items/show/563>.

included a reserved parking stall near the station.<sup>31</sup> While the system garnered national attention during the exposition, popularity for the aerial gondola as an alternative urban public transit system quickly diminished after the event ended. Though the MART provided public transit with spectacular views between two urban destinations, poor planning and timing failed to create a meaningful and long-term method of circulation within New Orleans. The subsequent lack of interest from west and east bank residents and low-ridership numbers failed to finance the MART, ultimately leading to its permanent closure and demolition.<sup>32</sup>



Figure 5. Mississippi Aerial River Transit

Source: World's Fair Photos<sup>33</sup>

### *Portland, OR*

The final and most recent aerial transit system constructed in the US was the Marquam Hill Aerial Tram in Portland, Oregon for the Oregon Health Sciences University

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<sup>31</sup> Ibid.

<sup>32</sup> Ibid.

<sup>33</sup> "MART Mid River", digital image, accessed March 1, 2017, <http://www.worldsfairphotos.com/neworleans84/images/mart-mid-river.jpg>.

(OHSU) constructed in 2007. Designed as an aerial tramway, the system was constructed as a solution to further expand one the area's largest institutions and strengthen the relationship between downtown and the newly developing areas. The OHSU had a sizable population, with approximately 11,000 employees which serviced around 200,000 patients annually. As the university's operations continued to increase, the institution needed to continue developing its campus, however, land around the university was limited and not conducive towards new construction. Instead of simply finding land elsewhere that would have been disconnected from its main location at Marquam Hill, the solution was to connect the University with the newly developing, 113 acre, South Waterfront with an aerial ropeway system. The University could then continue its development expansion with an integrated transit system that could connect to another streetcar extension that continued to circulate passengers towards the downtown area. The tramway consisted of two, 78 passenger cabins that shuttled passengers back-and-forth between the upper and lower stations. Between the stations, a prominent, 197 foot tower was constructed to support the guiding cables. Interestingly, this tower was given high-quality architectural design attention because of its prominent height within the area. Although the overall project had major cost overruns due to drastic design changes throughout the construction process, the extensive planning and high-quality design continues to financially support the transit system, as well as economically strengthen the surrounding area as people are able to more efficiently circulate throughout the city alongside other transit modes.<sup>34</sup>

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<sup>34</sup> Jeff Wood, *Hercules Aerial Tram/Mobility Study & Report*, Reconnecting America, 15-16, accessed October 4, 2016, <http://www.reconnectingamerica.org/assets/Uploads/aerialtram.pdf>.



Figure 6: Portland Aerial Tram, Oregon

Source: Marina Chetner<sup>35</sup>

While New York's Roosevelt Tramway, the New Orleans MART, and Portland's Marquam Hill Aerial Tram have served as spectacular, alternative means of urban movement, they have not been able to effectively inspire new construction of other aerial ropeway transit (ART) systems in other urban landscapes. After the construction of these projects, ART systems were studied and proposed in other cities including Denver, Cincinnati, Pittsburgh, and Detroit as potential transit alternatives, however, their plans were never implemented due to lack of sufficient financing as well as public and legislative support. Consequently, New York, New Orleans, and Portland have remained the only prominent ART systems to be constructed for the purpose transport passengers within the urban area in the US. Progressive cities- such as Georgetown, Austin, and Chicago- are currently exploring ART for their residents, however, new aerial ropeways in the US have yet to be constructed outside of recreational ski resorts.

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<sup>35</sup> "Portland Aerial Tram", digital image, accessed March 2, 2017, [https://marinachetner.files.wordpress.com/2012/09/dsc\\_0758ps.jpg](https://marinachetner.files.wordpress.com/2012/09/dsc_0758ps.jpg)

## 3.0 Assessment of Aerial Ropeway Transit

### 3.1 Benefits

Though ART is not a remedy for all transportation and development issues, the system provides unique advantages that can be of substantial benefit to those urban environments lacking sufficient mobility and access, particularly here in Honolulu. This section describes the characteristics and advantages of ART as a means for providing public transportation within the urban environment. This section also describes the existing system technologies as well as the major technical components to provide context for discussion on specific solutions for implementation. This section also addresses environmental, safety, and social considerations for ART.

#### *Terrain-Specialized Transportation*

While aerial ropeway can be utilized for a number/wealth of effectual advantages, the driving force behind it being selected specifically for urban environments is its ease and efficiency when traversing challenging topographical environments, such as bodies of water, valleys, and mountains. Because it operates above grade and does not require massive infrastructure, these systems have been able to transport people and materials across mountainous terrain, forested areas, and large bodies of water with minimal disturbance to the landscape below. Although aerial ropeway was not initially developed for dense urban environments, its ability to travel across challenging terrain of any nature, both natural or urban, is what makes the system a unique choice for cities looking to increase mobility as well as access.<sup>36</sup> This characteristic alone drives much of the growing interest in using aerial gondolas as urban public transit. As a complex and densely layered environment, the city has a multitude of physical and spatial barriers that not only divide communities internally, but also make it difficult to integrate large scale infrastructure.

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<sup>36</sup> Edward S. Neumann, "The Past, Present, And Future Of Urban Cable Propelled People Movers," *Journal Of Advanced Transportation* 33, no. 1 (1999): 51-82, doi:10.1002/atr.5670330106.



Vehicular infrastructure that was originally designed to provide fluid mobility throughout the city now inherently serves as a physical barrier not only limiting pedestrian movement but also dividing neighborhoods and communities. Thus, the aerial ropeway system's ability to traverse challenging terrain could effectively help to re-connect segregated and distant locations, at both different and similar elevations, without requiring any sort of demolition and/or restructuring of the existing development below it.<sup>37</sup>

#### *Smaller Infrastructure Footprint*

Another benefit that ART provides over conventional modes of transportation is the little amount of space needed in order to support the system's implementation throughout an entire city. Altogether, including its small number of terminal stations, ART has a much smaller overall construction footprint, which is primarily due to the greater distances between its support towers. Instead of a large concrete guideway, ART utilizes one to three suspended cables to direct passenger cabins between each terminal station. Furthermore, the lightweight and far-reaching nature of the cables allows for towers to be placed much further apart, thus reducing the required land acquisition needed on the ground below.<sup>38</sup>

#### *Less Expensive and Faster Implementation Than Rail Infrastructure*

Depending on the design and technology of the system, ART has the potential to be much less expensive than other transit modes such as heavy rail. The minimal amount of material resources needed for construction, the lesser degree of property acquisition, and the quicker implementation time are each, and altogether especially beneficial for those communities and cities that have limited spending resources.<sup>39</sup>

#### *Flexible Deployment*

One challenge that public transit systems frequently face is creating more efficiency

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<sup>37</sup> B. Alshalalfah et al., "Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art," *Journal of Transportation Engineering* 138, no. 3 (2012): 254-258, doi:10.1061/(asce)te.1943-5436.0000330.

<sup>38</sup> *Ibid.*, 254.

<sup>39</sup> *Ibid.*

and greater performance by improving the capacity utilization as a means to reduce the maintenance and operation costs. This challenge can be approached by changing the system capacity to fit peak and off-peak periods of demand, either daily or seasonally. For instance, employment centers will have higher periods of demand during the morning and evening hours for residents traveling to and from work; and neighborhoods with educational institutions will experience more intense traffic congestion during the fall and spring seasons. For example, the Swiss region of Bern recently installed a monocable gondola system that was able to vary the capacity by 75%, 50%, or 25% during operations. This was done by operating the system in a pulsed movement, where a cluster of cabins run in close sequences similar to a train. This arrangement also allows for several cabins to either be loaded or unloaded simultaneously.<sup>40</sup>

Another way of maximizing capacity efficiency is by integrating a specific number of cabins during the systems initial construction. While gondola systems have a maximum capacity based on the size and number of cabins that can be supported, a lower number of cabins could be installed to match the city's transit needs, which would in turn lower the upfront costs of the system. Additional cabins could then be installed later for cities that expect ridership demand to increase over time on account of population growth and a higher number of employment opportunities.<sup>41</sup>

### *Reduced Commute Times*

The ability to traverse over challenging terrain does not limit the system to following roadway networks. Traffic congestion, for example, is one of the world's most challenging mobility issues in an urban environment. Both automobiles and bus transit are vulnerable to crippling traffic during peak rush hour periods. However, ART can potentially provide quicker commute times as they travel in more direct pathways and do not need to stop at traffic lights, crosswalks, and/or intersections along meandering roadways.<sup>42</sup>

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<sup>40</sup> Baha Alshalalfah et al., "Improvements And Innovations In Aerial Ropeway Transportation Technologies: Observations From Recent Implementations", *Journal Of Transportation Engineering* 139, no. 8 (2013): 814-821, doi:10.1061/(asce)te.1943-5436.0000548.

<sup>41</sup> Bryce Tupper. Proposed Burnaby Mountain Gondola Transit Project, 20.

<sup>42</sup> B. Alshalalfah et al., "Aerial Ropeway Transportation Systems in the Urban Environment," 5.

In contrast to bus transit, ART does not rely on arrival schedules—the system is constantly circulating. Dependent upon their spacing, cabins arrive at the station platform every few seconds, which heavily increases schedule flexibility for its passengers since they do not need to rely on time-contingent arrivals and/or departures. In addition, for those who typically drive automobiles, their time (and money) typically spent on parking will no longer be necessary, only further reducing overall commute times.

#### *Automated Operation*

The automated operation for the system is also an advantage. Passenger cabins do not operate independently as power and propulsion occurs in the terminal stations—the system operates as a unified whole. Furthermore, operation and management only requires a few personnel to be onsite at each station; the ART system does not rely on and/or require a massive driver workforce as bus transit does.<sup>43</sup>

#### *Energy Efficient / Low Emission Rates*

Because power and propulsion originates at the system's terminals, cabins do not need individual engines or motors. Furthermore, most modern drive systems operate using electric power, only using diesel engines as a back-up when power outages occur. From a sustainability standpoint, ART is a much cleaner and energy efficient system than internal combustion vehicles, hybrid bus transit, and/or heavy rail. As cities are beginning to adopt more urban practices that aim to resist climate change, a transition towards cleaner transportation would help to establish Hawaii as a leader in sustainability.<sup>44</sup>

Overall, though the attractive benefits of this system have already prompted certain cities to integrate it into their respective urban environments, the system does have several characteristics that could potentially challenge its effectiveness within particular environments. However, because it is still a relatively new technology to be used as urban public transit, it has a large potential for improvement, especially as its application garners more interest from affluent metropolitan cities.<sup>45</sup>

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<sup>43</sup> Ibid.

<sup>44</sup> Ibid., 7.

<sup>45</sup> Baha Alshalalfah et al., "Improvements and Innovations In Aerial Ropeway Transportation Technologies," 12.

### *Limited Capacity*

Though ART systems can provide mobility and access to a large amount of people, capacity and speed currently do not match that of other rapid transit systems such as heavy and light rail transportation. In denser cities, where periods of demand are extremely high, ART may not be an appropriate choice as it may result in longer wait times to enter each cabin. However, major recent advances in the system's technology have enabled it the ability to greatly increase speed as well as capacity, thus allowing ART the potentiality of being an effective mode of transit. But as with implementation of any major transportation project, much consideration must be given to the site context, community, and ridership behavior before any construction is to occur.<sup>46</sup>

### *Privacy, Noise, and Aesthetics*

One of the biggest challenges with implementing ART into an urban environment is privacy and aesthetics. While ART passengers benefit from the expansive views, residents near an ART route understandably express concern over privacy, noise, aesthetics, and falling objects. Based on existing systems, ART is relatively quiet when compared to cars, buses, and/or trains. And, the benefit of having one central drive system is that cabins are relatively quiet as they circulate between the various mid-stations.<sup>47</sup>

Privacy is one of the more challenging aspects regarding the implementation of ART within a city. Traditional modes of transportation operate primarily on ground level with limited sightlines toward and into residential windows. However, the nature of ART provides public transit users a more elevated line of travel, increasing the possibility of direct sight lines into residential homes and apartments. It is inevitable that the system will initially concern residents, however there are strategies that have already been developed in order to help address the issue. One solution is to install transition glass into the passenger cabins. For example, the gondola in Brittany, France traverses near several apartment buildings as it approaches the downtown area: when the cabins come within a specified distance, the side windows of the cabin mist, or become opaque, restricting

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<sup>46</sup> B. Alshalalfah et al., "Aerial Ropeway Transportation Systems in the Urban Environment," 254.

<sup>47</sup> Ibid.

passenger views into residential space.<sup>48</sup> Another strategy used to alleviate concern is the creation of programs that purchase properties from homeowners who will be most affected by its presence. For example, the Portland Aerial Tram, which travels over residential homes at one section of its route, caused a number of residents to oppose the implementation because they were concerned with decreased home values. As a solution, the residents were then given the option to sell their properties to the city at fair market value.<sup>49</sup>

The infrastructures aesthetics are also a point of concern for residents because it is a system yet to be commonly seen and/or used within urban environments. Though aerial ropeways need greater architectural and design considerations than the current best practices require; with the exception of some, most systems have very similar mechanical aesthetics as the recreational gondolas. However, simply transplanting mountain ski systems into the city will likely receive a good amount of community resistance. As with any new development, the system must be constructed with consideration to the location, environment, culture, and architecture. For example, the gondola systems in both London and Portland allocate more design focus on the aesthetics of the system. And, while design focus did increase the project's overall cost, it also provided higher quality aesthetics to the more visually prominent gondola components.<sup>50</sup>

### *Safety*

Because the operation of aerial transit systems is not commonly understood as a method of transit, especially within a large urban area, concerns over passenger safety must be both addressed and understood. In relation to other modes of transportation, transit by means of aerial ropeway is rated one of the safest. The National Ski Areas Association, which maintains all aerial lift data, reported that since 1973, there have been a total of 12

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<sup>48</sup> Feargus O'Sullivan, "In France, A Fix For The Urban Gondola's Privacy Problem", Citylab, 2016, <http://www.citylab.com/cityfixer/2016/11/france-urban-gondola-privacy/508592/>.

<sup>49</sup> Bryce Tupper, Proposed Burnaby Mountain Gondola Transit Project., 17-18.

<sup>50</sup> Baha Alshalalfah, Amer Shalaby, and Steven Dale, "Experiences with Aerial Ropeway Transportation Systems in the Urban Environment," *Journal of Urban Planning and Development* 140, no. 1 (2014): 2, doi:10.1061/(asce)up.1943-5444.0000158.

fatalities due to system errors—this data includes both open chairlifts and enclosed gondola systems. Thus, the death rate for aerial systems is 0.14 deaths per 100 million miles traveled. In contrast, automobile deaths in the United States, 2014, totaled 35,400 people, with a death rate of about 1.16 for every 100 million-vehicle miles traveled. That being said, by comparison, aerial transit systems are nearly eight times safer than automobiles.<sup>51</sup>

As mentioned, the ANSI organization recommends safety standards, principles, and proper maintenance for all aerial lift designs here in the US. Furthermore, regulatory agencies frequently inspect the systems and carry out all ANSI guidelines in order to ensure that each aerial ropeway has the required safety features and backup systems needed to maintain and operate each system safely and efficiently.

One of the main concerns of aerial system safety is how to evacuate passengers when components on the main drive system fail, which could end up leaving many people stranded in their cabins. However, this problem can be mitigated by using a backup diesel engine which would resume transit operations in the case of an electric power failure. If the power does fail, the backup engine would allow passengers to quickly and safely exit their respective gondola cabins.<sup>52</sup>

Another major public safety concern is the security of passengers within the cabins themselves. Individual cabins do not have operating personnel onboard, therefore there is the perception that passengers may be less safe. While this may be true, security measures can be set in place to improve passenger safety. For example, systems such as the SkyTrain in Vancouver, Canada have alarms and intercom radios installed for passengers to quickly contact transit security of any health or safety issues. Cabins can also be fitted with video surveillance systems for added security. Having security operators stationed at the beginning and end of each traverse can also act as an effective deterrent to crime.<sup>53</sup>

As a potential mode of public transportation, accessibility for disabled passengers is absolutely necessary if aerial ropeway is ever to become a part of a city's multimodal

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<sup>51</sup> Baha Alshalalfah et al., "Improvements and Innovations in Aerial Ropeway Transportation Technologies", 7.

<sup>52</sup> Baha Alshalalfah, Amer Shalaby, and Steven Dale, "Experiences with Aerial Ropeway Transportation Systems in the Urban Environment," 3.

<sup>53</sup> Bryce Tupper, "Proposed Burnaby Mountain Gondola Transit Project," UniverCity On Burnaby Mountain, April 22, 2009, 17-18.

transit system. In some existing gondolas, aerial lifts often do not provide adequate accessibility, as passengers are sometimes required to quickly enter and step up into the passenger cabin, reducing access to disabled individuals. However, more recent designs provide wider doorway entries and exits as well as level thresholds between the cabin floor and the outside platform. With the detachable gondolas, cabins also move at very slow speeds and can be stopped completely to allow an easier walk-in for those individuals who may require more time and/or assistance. Cabin interiors can also be designed to accommodate wheelchairs, strollers, bicycles, and other large items.<sup>54</sup>

### 3.2 Major System Components

#### *Aerial Cabins or Carriers*

The aerial cabin, or vehicle, can be described as the motor-less carrier that physically contains the passengers and transports them from one geographic destination to another. Though shape and size vary greatly between different systems, all forms are comprised of the same basic mechanical components including the cabin itself, the cabin hanger, and the grip, all of which securely tie the whole carrier to the top supporting cable.<sup>55</sup> Depending on the type of system the cabin is used in, cabins can vary greatly in size and passenger capacity. Aerial tramway systems for instance require the largest cabins, while the gondola systems involve the use of small to medium sized cabins. Most cabins are entirely enclosed and have large viewing windows. Each cabin also typically has both seating- and standing-room, which allows for the maximum passenger capacity to be reached.<sup>56</sup>

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<sup>54</sup> Ibid.

<sup>55</sup> B. Alshalalfah et al., "Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art," *Journal of Transportation Engineering*, 262.

<sup>56</sup> Baha Alshalalfah, Amer Shalaby, and Steven Dale, "Experiences with Aerial Ropeway Transportation Systems in the Urban Environment," *Journal of Urban Planning and Development* 140, no. 1 (2014): 2, doi:10.1061/(asce)up.1943-5444.0000158.

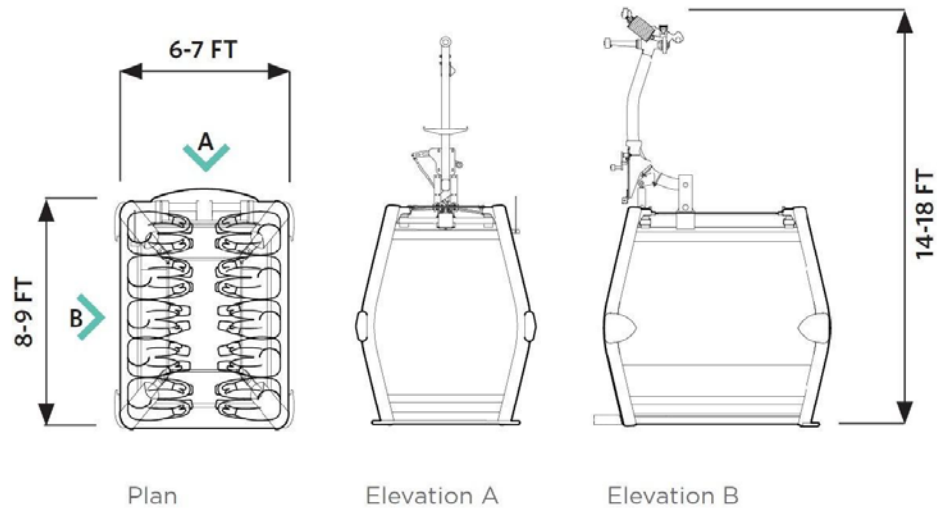


Figure 7. Monocable Detachable Gondola .

Source: Georgetown Rosselyn Gondola Study<sup>57</sup>

Passenger capacity can be defined as the maximum amount of passengers a transit system can hold and transport in a certain amount of time. As the main function of public transit is to move large amounts of people from their place of origin to their final destination, capacity of the aerial system is of the utmost importance when proposing it as a new form of urban transportation.<sup>58</sup>

The passenger capacity for an aerial system is greatly dependent on the length of the line, the spacing between carriers, and the size of the cabins themselves. However, the aerial system type is the determinant factor when estimating the maximum capacity. Different system types such as funitel, monocable, bi-cable, and tri-cable require specific cable assemblies and tower spacing, which dictates the size of the cabin and the speed it can travel.

### *Grip Modules*

<sup>57</sup> ZGF Architects LLC et al., *Georgetown-Rosslyn Gondola Feasibility Study* (Georgetown: ZGF Architects LLC, 2017), accessed March 1, 2017, <https://static1.squarespace.com/static/56be0bf0f85082283a801769/t/581b3129be6594f54cc7a225/1478177085024/GR-Gondola-TechSummary-110316.compressed.pdf>.

<sup>58</sup> Jeff Wood, *Hercules Aerial Tram/Mobility Study & Report*, Reconnecting America, Reconnecting America, 15-16, accessed October 4, 2016, <http://www.reconnectingamerica.org/assets/Uploads/aerialtram.pdf>.



As mentioned, the suspended cabins are motorless, meaning they are both supported and propelled by the overhead cable(s). This connection is what allows the circulating cable to provide movement to the cabin, ultimately moving passengers along with it. In order for this action to occur, there must be a secure connection between the cabin and cable. The grip, which is one of the most important mechanical components built into the cabin assemblage, provides a vice-like grasp on the cable, which prevents any shifting or movement once it is secure.<sup>59</sup>

The manner in which the cabin-grip clutches onto the cable can be divided into two primary classifications—attached assemblies and detachable assemblies. As evident from their names, these assemblies describe whether or not the aerial cabins can fully detach from the supporting cable. The detachable grip assembly comprises of heavy industrial springs which provide enormous pressure forces on a mechanical clamp in order to securely grasp the steel cable. The only way the grip's hold can be detached from the cable is if and/or when a targeted force at either of the station's terminals counteracts the elastic spring force, which then quickly releases the grip.

The ability for an aerial cabin to detach from the cable system is an essential feature for the operation of an efficient aerial transit system. Detachable grip modules enable the aerial cabin to disengage from the main propulsion haul cable while still in motion, without disrupting the continuous motion of the other cabins. As previously mentioned, when the cabin approaches a station terminal, the assembly is then detached from the main haul cable and greatly slowed down by another various mechanisms used within the station terminal. The cabin's greatly reduced speed allows passengers to safely enter and/or exit through its automatic doors. While the process requires calibrated mechanical synchronization between multiple mechanisms in order to operate, the detaching and reattaching process is performed smoothly, thus minimizing any passenger imbalance within the cabin.<sup>60</sup>

Another reason detachability is important is because it allows the cable-based system to make angle changes and turn corners, which is essential in most urban environments. As the passenger cabin approaches the turning station, the same pressure

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<sup>59</sup> Steven Dale, "Grip Module, Lesson 1: Introducing Grips," *The Gondola Project (Blog)*, accessed October 11, 2016, <http://gondolaproject.com/2009/12/18/grips-module-lesson-1-introducing-grips/>.

<sup>60</sup> Ibid.

mechanism detaches the grip module, allowing for the cabin to be redirected to an entirely different circulating cable. Once the cabin is aligned parallel to the new cable, the grip module is reattached and the cabin is able to continue along a new pathway on the same system. This process can either be performed at slower speeds, or at the same operating speed without slowing down.<sup>61</sup>

### *Drive Assembly*

As previously mentioned, the suspended passenger cabins are propelled by mechanically grasping on to the circulating steel cable, therefore there are no localized motors onboard any of the cabins. However, in order for the cable to move, an off-board engine system and moving cable components are needed to operate the lift. The engine, the mechanical components, the main support frame, and the computer constitute the drive assembly system. The primary drive system is typically located at one of the main station terminals—otherwise known as the wheelhouse—and houses the circulating haul cable as it rotates around several large-diameter metal wheels, all with a grooved outer edges, called the bull wheel or sheave. These sheaves are responsible for holding onto and changing the direction of the cable; they transfer the motive forces from the engine onto the haul cable, allowing cabins to accelerate and move around the aerial gondola system. Circumstantial to the site location, the drive system can either be located at the top or the bottom of the station. However, drive systems located at the higher station tend to be more energy efficient. At the terminal, the drive can either be designed as an aboveground, overhead station providing easier maintenance accessibility, or hidden underground to create a smaller and slimmer station profile. Because many drive systems run on electric power, a diesel emergency drive system is also set in place in case of an emergency and/or power failure.<sup>62</sup>

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<sup>61</sup> Ibid.

<sup>62</sup> Leitner Ropeways. "The Leitner Drive System," April 2014, Accessed October 12, 2016. [https://www.leitner-ropeways.com/fileadmin/user\\_upload/pages/The\\_LEITNER\\_Drive\\_System.pdf](https://www.leitner-ropeways.com/fileadmin/user_upload/pages/The_LEITNER_Drive_System.pdf).

### *Station Terminals*

Every ART system requires at least two terminals to function; one housing the mechanical propulsion system, and another providing the directional return. If the geographical location of the ART system is used to provide transit between different altitudes, then each station is characterized as being either the system's upper station or lower station. In detachable systems, areas for storing the cabins are needed; and in most cases, space is allocated either on the loading platform or at a lower level of the terminal.

Aside from housing the mechanical equipment, the stations are where passengers load and unload the carrier cabins. In a detachable gondola system, cabins are able to slow down, or stop completely, allowing for the loading and unloading of passengers. Because ART is a continual system, passenger loading and unloading occurs simultaneously at different locations on the platform, providing a quick and efficient transfer of passengers. While a minimum of two station terminals are required—one at either end—in order to operate a single aerial ropeway route, intermediary stations, otherwise known as *mid-stations*, can be placed between terminal stations to increase pedestrian access to the system.<sup>63</sup>

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<sup>63</sup> Baha Alshalalfah, Amer Shalaby, and Steven Dale, "Experiences with Aerial Ropeway Transportation Systems in the Urban Environment," 2.



Figure 8. Emirate Air Line, Lower Station Terminal, London, UK.

Source: Building.co.uk<sup>64</sup>

### *Angle Station*

Because the nature of ART generally requires direct alignments, current technology requires that an angle station be constructed to provide the necessary mechanical equipment that allows for a direction change. Angle stations can also double as passenger boarding and existing platforms.<sup>65</sup>

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<sup>64</sup> "Technical Case Studies On Infrastructure Projects | Building", *Building.Co.uk*, accessed 6 April 2017, [http://www.building.co.uk/Pictures/web/f/c/y/Cable\\_Car-608\\_660.jpg](http://www.building.co.uk/Pictures/web/f/c/y/Cable_Car-608_660.jpg).

<sup>65</sup> ZGF Architects LLC, "Georgetown-Rosslyn Gondola Feasibility Study," (Georgetown: ZGF Architects LLC, 2017), <https://static1.squarespace.com/static/56be0bf0f85082283a801769/t/581b3129be6594f54cc7a225/1478177085024/GR-Gondola-TechSummary-110316.compressed.pdf>.

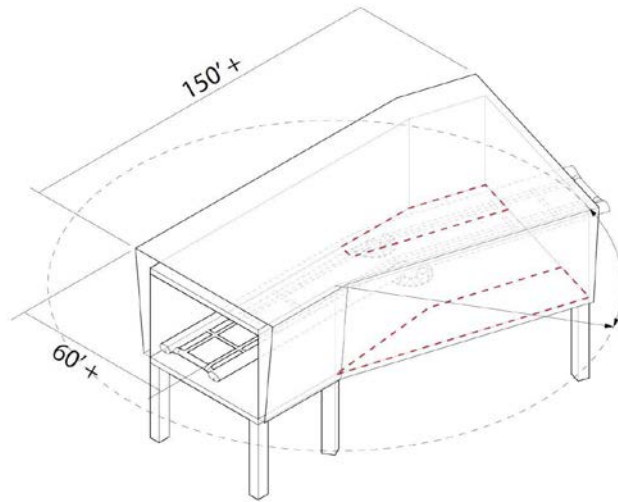


Figure 9: Angle Station.

Source: Georgetown – Rosslyn Study<sup>66</sup>

### *Towers*

The towers are one of the most visually prominent components in an aerial gondola system. These are the intermediate structures which provide support to spanning haulage and tracking cables between the terminals. Besides providing support, they also allow the movement of haul cable through a series of wheels at the top of the tower. Although the structures can vary, most commonly towers are constructed with concrete pillars, steel lattice, or steel cylinder structures.<sup>67</sup> Towers may not be necessary depending on the length and design of the system, but routes with longer spans usually require them. Reducing the number of towers can also help to lower the overall cost as well as the aesthetics; however, significant cable sag and lower traveling heights can result from spacing towers at greater distances.<sup>68</sup>

As previously mentioned, design and aesthetics are a critical issue for a project's development and approval. Since towers are the tallest components to a system, planners and designers must ensure that its placement does not negatively impact the surrounding view angles.<sup>69</sup>

<sup>66</sup> ZGF Architects LLC, "Georgetown-Rosslyn Gondola Feasibility Study," 7.

<sup>67</sup> Bryce Tupper, Proposed Burnaby Mountain Gondola Transit Project., 15.

<sup>68</sup> ZGF Architects LLC, "Georgetown-Rosslyn Gondola Feasibility Study," 14.

<sup>69</sup> Ibid.,

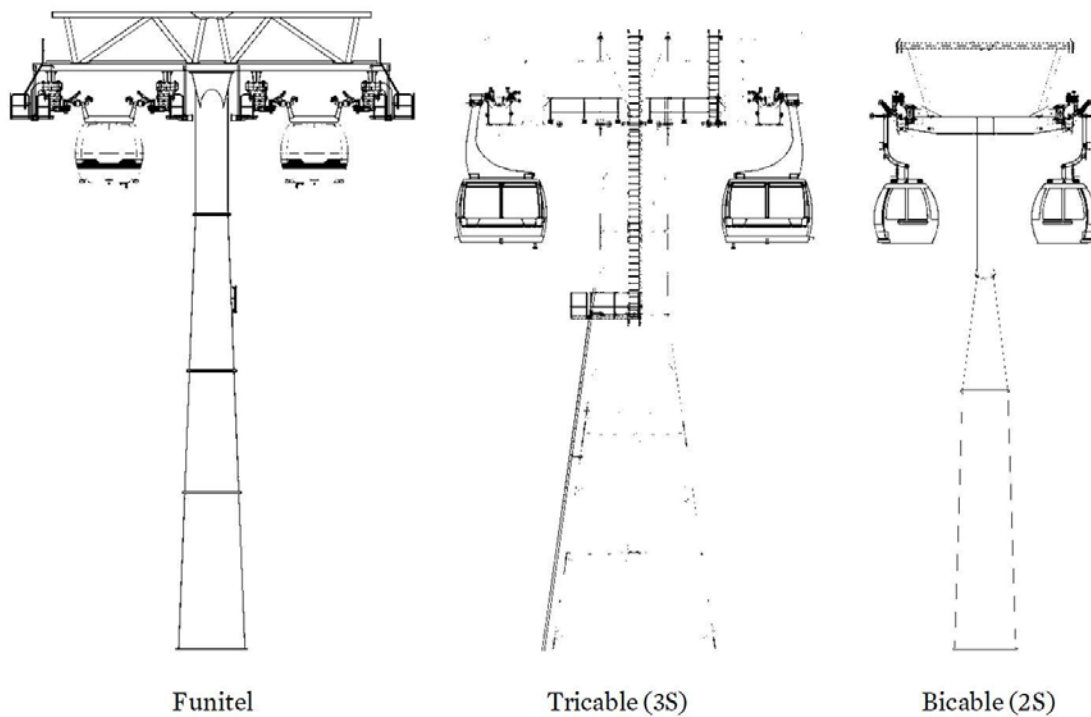


Figure 10: Tower Diagram.

Source: Burnaby Mountain Feasibility Report<sup>70</sup>

### *Cables*

The ropeway cable is considered the defining backbone of ART. Comprised of high-quality steel, the rope is constructed by inter-twining individual wires to form strands, then multiple strands are wound together to form the rope or cable. The cables serve individual or multiple functions depending on the system technology, but primary functions include providing guided support for the cabins (track rope) or providing cabin propulsion (haul rope). During the last phases of construction, the cable ropes are spliced from end to end to create an endless loop. Once installed, the cable is able to withstand the enormous tensile stresses demanded by the system for the life of the system. Cable sizes are measured by their diameter, and common sizes range from 1-1/8" to 1-7/8" diameter depending on the cable function.<sup>71</sup>

<sup>70</sup> Bryce Tupper, Proposed Burnaby Mountain Gondola Transit Project., 15.

<sup>71</sup> "About Ropeways," *Arthur Lakes Library: Colorado School of Mines*, accessed November 05, 2016, <http://inside.mines.edu/LIB-Ropeway-About>.

### 3.3 System Technologies

#### *Aerial Tramways*

While still considered an aerial ropeway system, an aerial tramway differs from more commonly known systems because it utilizes only two suspended passenger cabins located on opposite ends of the entire system. Though the number of cabins used is much lower than other ropeway systems, tramway cabins are much larger and can transport larger groups of passengers in a single trip. Depending on the design of the system, a single tramway cabin can carry between 6 and 200 passengers at a time, allowing it to transport between 500 and 2,800 passengers per hour depending on the speed and travel distance. The drive system, which includes the electric engine that powers the tramway, is more commonly located at the lower station terminal. This allows the power source to efficiently pull the weight of one tramway cabin downhill with the assistance of gravity, while simultaneously pushing the other tramway uphill. And, because both cabins move in opposing directions at either end of the cable, they depart from their stations simultaneously, passing each other at a single moment midway through the trip.<sup>72</sup> One benefit of a limited cabin system is the perceivably lower visual impact it has on the neighboring residents. Aerial tramways would have only one or two cabins passing each other every few minutes, as opposed to a constant flow of smaller cabins passing every few seconds.<sup>73</sup>

However, while tramways have a higher, single-trip carrying capacity than any other aerial ropeway system, there are several drawbacks that limit their use to specific landscapes and urban settings. Aerial tramways, like other ART systems, utilize multiple cables for both support and propulsion. However, the difference between the two lies in the mechanical grip: with aerial tramway, the cabins are permanently attached to the cable during operation, meaning the cabin does not have the ability to detach when it approaches

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<sup>72</sup> B. Alshalalfah et al., "Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art," 255.

<sup>73</sup> Steven Dale, "Aerial Technologies, Lesson 5: Aerial Trams," *The Gondola Project (blog)*, April 24, 2010, accessed November 02, 2016, <http://gondolaproject.com/2010/04/24/technologies-module-5-aerial-trams/>.

a terminal. This restricts the system's capability to make directional turns and limits the route to a straight line between passenger terminals, ultimately restraining the geographical environment over which the system can traverse. This also restricts the suspended cabins from circulating through the entire system, as it requires the cabins to only move back and forth along the same route, which essentially limits the number of cabins to two.<sup>74</sup> And, because a back and forth system limits the number of cabins to two, it creates a much longer passenger wait time before each departure. Since both cabins run in opposing directions, they must depart from opposite terminals at exactly the same time. Consequently, both shuttles must be ready before either can leave the terminal. And due to the limited number of cabins, if passengers miss the cabin's departure time, they then must wait for the next shuttle to arrive, which can be up to several minutes depending on the length of the tramway.<sup>75</sup>

#### *Monocable Detachable Gondolas*

The monocable detachable gondola is the most widely used aerial ropeway system around the globe and was originally designed for recreational ski resorts. This gondola system utilizes only a single looping cable that provides both the support and movement for the suspended cabins. The MDG system, like every other ropeway system, is driven by an electric engine drive system, which propels the cable around a bull wheel. However, unlike aerial tramways, gondola systems have detachable cabins that are both frequently and evenly spaced, and circulate along the full length of the looping cable that travels through each terminal. Detachable grips allow the cabins to slow down as they approach the terminal as well as maneuver around corner turning stations—a necessary feature for more challenging urban environments.

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<sup>74</sup> Ibid.

<sup>75</sup> Ibid.





Figure 11: Monocable Gondola, La Plagne, France.

Source: Pixabay<sup>76</sup>

The primary characteristic that sets MDG systems apart from the others is their simplistic nature. MDGs have a single cable, which in turn minimizes the complexity of the mechanical components within the terminal as well as the service required to maintain and repair the system. In addition, minimal system requirements greatly reduces the overall cost, making MDGs the simplest and most cost-efficient system to construct; which is also why the systems are already being used as successful methods of urban transit in various developing countries, one being South America.<sup>77</sup>

While MDG systems have substantial benefits, there are several drawbacks that also limit MDG systems in regards to their use. First, the single spanning cable is only capable of supporting a limited amount of weight at a slower speed. This means that cabins are generally smaller—capacity of about 4 to 15 people—depending on the cable size and spanning distance between support towers. Overall, the system is able to transport about 3,000 people per hour, per direction (pphpd), which is more than tramways but still considerably less in comparison to other systems.<sup>78</sup>

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<sup>76</sup> "Free Image On Pixabay - Aerial, Air, Alpine, Cabin, Cable", *Pixabay.Com*, 2017, accessed April 1, 2017, [https://pixabay.com/p-15960/?no\\_redirect](https://pixabay.com/p-15960/?no_redirect).

<sup>77</sup> Ibid.

<sup>78</sup> B. Alshalalfah et al., "Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art," *Journal of Transportation Engineering*,

Another disadvantage of using the MDG system is that a single support cable carries less stability in high winds. Since only one cable provides support and propulsion functions, cabins are more prone to swaying during periods of strong winds. While the system can still operate safely in low to moderate wind conditions, stronger wind conditions can temporarily shut down the system, potentially leaving an important transit route out of service.<sup>79</sup>

#### *Bicable Detachable Gondola*

The next major commonly used system is the bicable detachable gondola, or BDG, which uses features from both MDG systems and aerial tramways. While the BDG still utilizes full circulating, detachable-grip cabins, the cable system utilizes two different cables for support and propulsion; the stationary support cable provides suspension to the cabins, and the haul rope delivers forward and backward propulsion. One benefit of the BDG system is that it uses two cables, allowing for longer spanning distances between terminals and support towers, compared to the single-cable MDG systems. There is also an increase in maximum operating speed, as well as a moderate increase in stability when operating in high wind conditions.<sup>80</sup>

While allocating support and propulsion function to two different cables can provide improvements in stability and distance, the benefits may not be substantial enough to justify the increased cost due to the added complexity of the additional cable. Cabin capacity and maximum system capacity still remain about the same when compared to the less complex, cheaper MDG system.<sup>81</sup>

### 3.4 Advanced Systems

#### *Dual-Haul Aerial Tramway*

The dual-haul aerial tramway is the most recent advancement in aerial tramway systems. Like the traditional tramway, the dual-haul tramway uses two cabins that reverse

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<sup>79</sup> Steven Dale, "Aerial Technologies, Lesson 2: MDG," *The Gondola Project*, January 24, 2010, accessed November 4, 2016, <http://gondolaproject.com/2010/01/24/technologies-module-2-mdg/>.

<sup>80</sup> B. Alshalalfah et al. *Aerial Ropeway Transportation Systems in the Urban Environment*. 254-258

<sup>81</sup> Steven Dale, "Aerial Technologies, Lesson 2: MDG," *The Gondola Project*, January 24, 2010, accessed November 4, 2016, <http://gondolaproject.com/2010/01/24/technologies-module-2-mdg/>.

back and forth over parallel guideway cables. Where the traditional system uses one cable system for both cabins, the dual-haul tramway uses one cable for each cabin. The benefits of using an independent cable systems allows individual cabins to operate independently from one another, which in turn maximizes passenger efficiency, energy efficiency, and maintenance efficiency. When ridership is low, one tramway can be kept in operation to reduce energy consumption while the other is temporarily shut down. An inoperable tramway could also be serviced without temporarily halting the entire system.<sup>82</sup>

Though the dual-haul aerial tramway has many advantages, it also has its drawbacks. The operating speed of a dual-haul tramway is slower, at 18 mph, compared to the traditional system that operates at 26 mph. Also, cabin passenger capacity is reduced to 110 people per cabin, resulting in a maximum capacity of 2,000 pphpd; however, the passenger efficiency is greater when demand is low.<sup>83</sup>

#### *Tri-cable Detachable Gondola*

Similar to the MDG and BDG systems, the tri-cable detachable gondola system, otherwise known as 3S, also shares features with the BDG and the aerial tramway. However, the 3S system uses an additional stationary support cable to provide a number of system performance benefits. This 3rd support cable provides a much greater increase in stability when operating in high wind conditions of up to 68 mph—a major benefit for areas vulnerable to stronger winds, as the entire system would not require any sort of temporary shutdown. The increased support also allows the cable system to span up to 1.86 miles between towers. Furthermore, the added stability allows the cables to hold larger cabins, increasing individual cabin capacity to 35 passengers and carrying anywhere from 6000 to 8000 people per hour in each direction. The additional support cable also reduces the sway effect often felt in both MDG and BDG systems.<sup>84</sup>

Though there are substantial benefits to the 3S system when compared to other aerial ropeways, there are also some downsides that should be taken into consideration. One of the major criticisms of 3S systems is its high cost. Because it is the most modern

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<sup>82</sup> B. Alshalalfah et al. *Aerial Ropeway Transportation Systems in the Urban Environment*. 254-258

<sup>83</sup> B. Alshalalfah et al., *Improvements and Innovations in Aerial Ropeway Transportation Technologies*, 8-9.

<sup>84</sup> B. Alshalalfah et al. *Aerial Ropeway Transportation Systems in the Urban Environment*. 254-258

evolution of aerial technology, it uses more complex mechanical systems within the station terminal. Increased stability, speed, spanning distance, comfort, and safety features all rely on the most current technology to operate. While most US cities can afford to implement these newer systems in their urban environments, developing countries around the world may not be able to afford them. Another drawback with 3S systems is that they require a larger support tower. The system can span up to 1.86 miles between towers, greatly reducing the number of towers needed, however the increase in horizontal and vertical forces creates a greater tensioning load on the cables. This ultimately requires the towers to support much heavier loads, thus resulting in a larger support tower. Though the number of towers are fewer, a large support tower usually uses a lattice support structure with a 75 ft x 75 ft footprint.<sup>85</sup>



Figure 12: Tri-cable Detachable Gondola, Ischgl, Austria

Source: Doppelmayr<sup>86</sup>

### 3.5 System Evaluation

For an aerial ropeway system to operate effectively and achieve its greatest social

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<sup>85</sup> B. Alshalalfah et al., *Improvements and Innovations in Aerial Ropeway Transportation Technologies*, 12-15.

<sup>86</sup> "28-TGD Pardatschgrat", *Doppelmayr*, accessed 6 April 2017, <https://www.doppelmayr.com/en/products/references/28-tgd-pardatschgrat/>.

and economic potential, careful consideration of both current and future ridership patterns, area demographics, land use zoning, surrounding site buildings, and system technologies must be thoroughly analyzed. After careful consideration of each technology's characteristics, as well as O'ahu's climate and physical environment, it was determined that the 3S gondola would be the most appropriate system to meet Honolulu's needs.

One of driving factors that narrowed the possible system choices was O'ahu's generally windy climate. Because of Hawai'i's geographic location in the Pacific Ocean, O'ahu experiences constant trade winds year-round, which blow on average at 10-15 miles per hour, with higher speeds reaching the 20-30 mile per hour range. Hawai'i is also vulnerable to seasonal hurricanes and tropical storms, which can bring much stronger winds and heavy rainfall, so the infrastructure needs a high level of resiliency. As previously stated, monocable and bi-cable systems sometimes need to suspend operation during periods of high winds, which would be an unacceptable characteristic for a major transit system in Hawai'i. Therefore, the 3S gondola would provide the highest reliability in the event of greater wind speeds.

The larger passenger capacity of the 3S system is also more appropriate for Honolulu's urban environment. The Ala Moana Terminal Station is expected to experience a volume of approximately 22,610 people arriving at and boarding the train each day. Most will arrive at peak hours in the morning and evening, and travel to destinations beyond the Ala Moana Shopping Center.<sup>87</sup> Thus the ART will need to handle high passenger demand to ensure that people are not waiting for an unreasonable amount of time to board a cabin. The 3S gondolas are able to handle a maximum of 6,000 people per hour per direction (pphpd), and working in conjunction with Honolulu's bus system, a high level of transit demand will be capable of being met.<sup>88</sup>

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<sup>87</sup> Honolulu High-Capacity Corridor Project: Final Environmental Impact Statement / Section 4(f) Evaluation (Honolulu, HI: City and County of Honolulu, 2010), accessed October 24, 2016.

<sup>88</sup> Bryce Tupper, Proposed Burnaby Mountain Gondola Transit Project, 15.

	Monocable	Bi-Cable	3S	Tramway / Funitel
Maximum Capacity (pph)	3600	4500	6000	2000
Cabin Capacity (passengers)	8	20	35	150
Maximum Wind Speed (mph)	37	50	62	50
Lift Speed (mph)	13	16	19	26
Tower Spacing	0.18	0.9	1.8	1.8

Table 1: Aerial Ropeway Technology Comparison

Source: Doppelmayr<sup>89</sup>

Due to the dense building environment and narrow roadways, especially around Waikīkī, Honolulu's is somewhat of a restrictive location in terms of constructing multiple support towers. And, the 3S gondola system's ability to provide greater spans between stations and towers, reduce the potential land acquisition needed for construction; again, making it the best option for Honolulu's urban environment<sup>90</sup>

Since a majority of Honolulu's ART riders will be residents, commute time will be an important factor in determining the most appropriate system technology. Once again, the 3S provides one of the highest maximum cabin speeds, at 19 miles per hour. While bi-cable and tram systems operate at comparable speeds, they do not possess the necessary characteristics that 3S is able to provide for Honolulu's urban environment.<sup>91</sup>

After assessing the major benefits and drawbacks of each system, as well as the site

<sup>89</sup> "3S Gondola Lift", *Doppelmayr*, brochure, accessed 6 April 2017, <https://www.doppelmayr.com/en/products/3s-gondola-lift/brochure/browse-the-brochure-24/>.

<sup>90</sup> Bryce Tupper, Proposed Burnaby Mountain Gondola Transit Project., 30.

<sup>91</sup> *Ibid.*, 15.

characteristics and routes between each location, this research suggests that 3S would provide the greatest benefits to Honolulu despite the system's overall higher cost. As a newer technology, 3S can provide a more efficient, more comfortable, and more reliable system than older system technologies. However, it should be noted that these assessments are preliminary and further analysis into financial, economic, and technological risk assessment should be done in cooperation with the city and ART manufacturing companies.<sup>92</sup>

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<sup>92</sup> Ibid.,24.

## 4.0 Contextual Understanding

Based on community improvement strategies, preliminary site assessments, and favorable factors for growth- three locations in Honolulu were determined to be important economic and social centers east of the Ala Moana Station. Waikīkī, UH Manoa, and Kaimukī were identified as major urban destinations that possessed aspects conducive to a more successful urban environment. These characteristics included having large residential populations, being major centers of employment, having nearby educational institutions, and attracting large volumes of people from surrounding neighborhoods including areas ‘Ewa of Ala Moana Station.

This chapter describes the underlying character and relevance of these locations within the city, as well as identifies community destinations and assets. Additionally, current and future key development issues are described to determine how ART could potentially provide solutions for them.

### 4.1 Ala Moana

#### *The Shopping Center / Rail Station*

As the state’s largest commercial destination, strategically located between Waikīkī and downtown Honolulu, Ala Moana Shopping Center is another location that strongly substantiates ART’s transportation and community benefits. Ala Moana Shopping Center currently attracts more than 48 million resident and visitor shopping trips per year to its 290 businesses which accumulate more than \$1 billion in yearly sales.<sup>93</sup> And, because of its distinct location in the center of urban Honolulu, the shopping center also plays a major transportation role in the community, acting as a popular transit hub for local bus connections. The shopping center is also supported by important surrounding areas including the residential neighborhood, Ala Moana Beach Park, and adjacent plots designated for future mixed-use development.

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<sup>93</sup> GGP, Ala Moana Center - Mall Fact (Honolulu: GGP Investors, 2015), <http://www.alamoanacenter.com/About-Us.aspx>.



Due to higher population growth and increasing tourism, Ala Moana has continued to see rising profits as a result of its significant expansion and new development that has taken place over the past decade. The major expansion and redesign of the shopping center's 'Ewa wing was recently unveiled in 2015, and largely increased the number of businesses within the shopping center. In addition to Ala Moana Shopping Center's new wing, a 23-story luxury condominium tower was completed in 2014, and seven 8-story luxury condominiums are currently under construction located on the makai/ocean side of the shopping center.<sup>94</sup>

Ala Moana Shopping Center will also be the final terminus for the rail project along O'ahu's southern shore. As a major economic center with a high concentration of employment in and around the area, transit projections estimate 22,610 people are expected to arrive and depart at the station daily—individuals comprised mainly of O'ahu residents traveling to and from work or school. Because the Ala Moana district is one of Honolulu's major urban centers and among the most urban neighborhoods along the rail line, “adding new transit-oriented land uses within the area is imperative both to revitalizing the neighborhood and creating a truly livable urban community”.<sup>95</sup> Important features include compact development within walking distance of the rail station, revitalization of underutilized parcels along major travel corridors, expansion of the existing bicycle network, amenities that make urban living convenient and pleasant, diversification of housing options, residential livability, pedestrian connectivity, public parks and gathering spaces, streetscape improvements, enhanced landscaping and natural features. These elements, including the implementation of urban design principles, help to emphasize neighborhood identity and protect existing assets, as well as support a balanced multimodal transportation system.

And, although an important part of rail includes plans to implement these transit-oriented development strategies/policies for the rail station's surrounding Ala Moana neighborhood; because the Ala Moana station is the rail project's final stop and the TOD precinct contains boundaries based upon proximity to the rail station- i.e. pedestrian access

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<sup>94</sup> "GGP/AMC/CITI Investor Presentation for Ala Moana Shopping Center", (Presentation, 2013).

<sup>95</sup> CallisonRTKL, Belt Collins Hawaii, Fehr & Peers, Keyser Marston Associates, *Ala Moana Neighborhood Transit Oriented Development Plan*, 40.

within a 5- to 10- minute walking distance or ¼- to ½- mile radius- ART will be a catalyst for continual integration of those same TOD policies past Ala Moana in areas the rail project does not reach.<sup>96,97</sup> Furthermore, as the Ala Moana Center station is projected to be the largest boarding station along the entire rail line, the integration of ART will not only help to expand transit options for those traveling to and from the Ala Moana Shopping Center, but also improve waiting times and minimize overcrowding for all other modes of transportation. And, because public input via various community outreach efforts were essential in preparing the Ala Moana Neighborhood TOD Plan, ART can then utilize the already both privately and publicly approved TOD information to help support further development growth.

### *The Neighborhood*

Ala Moana is an urban district, featuring a balance of commercial and residential uses that are supported by numerous civic institutions and community facilities. Commercial and institutional uses promote local and tourist economies through major shopping nodes and low intensity, underutilized commercial corridors. There also exists a wide demographic due to the variety of housing choices, as well as the range of shopping and services that conveniently meet day-to-day needs. Ala Moana is bordered on the ‘Ewa side by the Kaka‘ako neighborhood.

Secondary shopping nodes, which appeal primarily to locals, are located mauka of Kapiolani Boulevard, and include the Sam’s Club, Walmart, and Don Quijote Supermarket. The proposed Ala Moana Center station, situated on the mauka side of Ala Moana Center, is located each of these major shopping nodes. Another commercial node ‘Ewa of Ala Moana Center is the Ward Centers retail and entertainment development, which will be served by the Kaka‘ako rail station. In addition to these shopping attractions, low-intensity commercial activity is found along the area’s arterial and collector roadways. Kapiolani Boulevard in particular, functions as the area’s primary commercial corridor with older, low-rise buildings gradually being replaced by newer, higher value high-rise mixed-use

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<sup>96</sup> Ibid., 42

<sup>97</sup> Ibid., 10

buildings. Much of the areas along Ke‘eaumoku Street, Sheridan Street, Kalakaua Avenue, and King Street are similarly underdeveloped with low-density commercial uses.<sup>98</sup>

### *Residential*

Residential use is concentrated east and west of the Ke‘eaumoku Corridor. The area east of Ke‘eaumoku is developed at a higher density, and includes a number high-rise apartment buildings including the Kalakaua Homes public housing project. The area west of Ke‘eaumoku Street is the Sheridan Tract, characterized by low to medium density residential structures, including a single-family houses and low-rise apartment buildings. Additional higher concentrations of housing are found in the Makiki and McCully districts, with new high-rise condominiums beginning to emerge in Kaka‘ako.<sup>99</sup>

### *Development Opportunities*

Underdeveloped commercial properties along Kapiolani Boulevard are prime redevelopment opportunities. Redevelopment of these parcels provides the best opportunity for transit-oriented development within ¼ mile of the Ala Moana Center station and would contribute to Kapiolani Boulevard’s transformation into a highly identifiable, high-density, mixed-use corridor linking downtown Honolulu and Waikīkī.<sup>100</sup>

Properties located at or near the intersection of Kapiolani and Kalakaua present another important redevelopment opportunity. Although this intersection is located about ½ mile from the station, its situation as a gateway to Ala Moana and Waikīkī and the presence of the Convention Center make this a crucial location. Activating this node through redevelopment will capitalize on the presence of the Convention Center and reinforce Kapiolani as a major mixed-use corridor.<sup>101</sup>

Lower priority redevelopment opportunity sites are located along major arterial and collector streets just beyond these nodes. Nonetheless, redevelopment of low-intensity

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<sup>98</sup> Ibid., 25

<sup>99</sup> Ibid., 26

<sup>100</sup> Ibid.

<sup>101</sup> Ibid.

commercial properties along Kalakaua Avenue and King Street, as well as Ke‘eaumoku and Sheridan Streets, will further promote transit and a pedestrian-friendly mix of uses.<sup>102</sup>

### *Gateway Opportunity*

The intersection of Kapiolani Boulevard and Kalakaua Avenue also offers a unique development opportunity as it centrally located between Ala Moana and Waikīkī, and immediately adjacent to the Hawaii Convention Center. Aside from being located next to Honolulu’s major civic center, this area is considered a gateway because it marks the major access point when entering the Waikīkī area. Additionally, it is also where three zoning districts converge, making it a demographically diverse area that is heavily traveled by all modes of transportation. The gateway location is indicated by the red circle on the illustration below.



Figure 13: Ala Moana Zoning Map and Gateway Location.

Source: Made By Author

<sup>102</sup> Ibid.

## 4.2 Waikīkī

Waikīkī is located less than a mile from Ala Moana Center and is the backbone of O‘ahu’s tourism industry—the driving force in Hawaii’s economy. The area covers approximately one square mile of shoreline and is a densely-built environment made up of high-rise hotel towers, apartment buildings, restaurants, shopping centers, and businesses catered toward O‘ahu’s visitors and residents alike. Historically, Waikīkī was once the playground for elite families and Hawaiian royalty. The island’s “royal playground” essence still lingers as the area has become a premier international travel destination, though due to steady development growth and increasing visitor interest, Waikīkī has become a more modern urban center for tourism.<sup>103</sup>

In 2015, O‘ahu alone saw a combined 8,563,018 domestic and foreign visitors with 81,782 people visiting Waikīkī daily; and, future projections indicate up to 9,355,000 visitors during the year 2019. Furthermore, according to ESRI’s demographic summary, Waikīkī’s population for 2016 totals 25,081 and projects the population to increase to a total of 26,713 in the year 2021, while job positions in the area are expected to rise from today’s 38,085 to 49,100 in the year 2030. And, with a high proportion of total transportation trips already being made to and from Waikīkī each day, a growing population, rising employment opportunities, and the soon-to-be, nearby rail station will only further increase the number of daily trips made to and around the area.<sup>104</sup>

In addition to being a source of employment, income, and tax revenue, Waikīkī is also one of the state’s major economic growth assets through its role as a resort destination. In regards to that role, Waikīkī-based visitor expenditures thus facilitate the injection of billions of outside tourist dollars into the rest of the economy. However, because of the projected growth and continual influx in visitor numbers each year, O‘ahu is going to have to find a way to continue catering to its increasing Waikīkī visitors—providing them with a richer experience and fulfilling both vacation and living expectations while being able to

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<sup>103</sup> *Waikiki Regional Circulator Study*, report, Department of Transportation Services (Honolulu, HI: Weslin Consulting Services, 2013), 13-16.

<sup>104</sup> "Traffic Counts—Esri Demographics Arcgis", Doc.Arcgis.Com, 2016, <https://doc.arcgis.com/en/esri-demographics/data/traffic-counts.htm>.

keep up the paradisiacal destination reputation that is indispensable to the tourism industry and thus to the stability and growth of the state's economy.<sup>105</sup>

### *Neighborhood Land Use*

Waikīkī can be classified as having a combination of *Resort Mixed Use Precinct*, *apartment mixed use precincts*, and *apartment precincts*. Majority of the commercial activity in Waikīkī occurs at the ground level along Kalakaua and Kuhio Avenues; thoroughfares which run parallel to the beach and responsible for circulating vehicular traffic. The majority of the activity is focused in the center of Waikīkī; bounded by Saratoga Road, Kuhio Avenue, and Kapahulu Avenue. Another point of commercial activity is also focused on the 'Ewa end of Waikīkī, across from Fort DeRussy Beach Park. The most well-known and frequented commercial nodes include the Royal Hawaiian Shopping Center, The Duty Free Galleria, Waikīkī Beach Walk, and the newly developed International Market Place.

### *Residential*

There also exists a large residential population in the Waikīkī, with majority living in mid and high-rise apartment buildings and a smaller population living in old, single-family homes. Most of the residential blocks are situated on the Diamond Head side of Waikīkī and along the Ala Wai Canal, with a small cluster of apartments situated on the 'Ewa end of Waikīkī, bounded by the Ala Wai Canal and Ala Moana Boulevard.

### *Community Assets*

Several community assets are located within and near Waikīkī. The most notable assets are Kahanamoku Beach, Kuhio Beach, and Queens Beach, which run along majority of Waikīkī's neighborhood. Other nearby assets include the Honolulu Zoo and Kapiolani Park, which lies on the Diamond Head end of Waikīkī along Kuhio Avenue, and the 'Āinahau Triangle, Waikīkī's only central open green space. Though the 'Āinahau Triangle

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<sup>105</sup> DBEDT, *The Economic Contribution Of Waikiki*, DBEDT E-Reports (Honolulu: The City and County of Honolulu, 2003), [http://files.hawaii.gov/dbedt/economic/data\\_reports/e-reports/econ\\_waikiki.pdf](http://files.hawaii.gov/dbedt/economic/data_reports/e-reports/econ_waikiki.pdf), 1-7.

spatially separates the activity nodes on either end of Waikīkī, the open area is valued by Waikīkī's residents.

### *Key Issues*

In order for Waikīkī to continue attracting both domestic and foreign visitors successfully—in such a way that gives them a reason or desire to return—serious attention must be paid to the current and outstanding issues regarding congestion, transportation, traffic, and transit; all of which will only get worse as the O‘ahu’s population continues to grow. One issue in particular involves the separation and segregation of zoning and topography within the Waikīkī area itself.

Early Waikīkī masterplans had called for strict separation between residential and resort areas. Emphasis was given on spurring more residential growth out of fear of overdevelopment of commercial and resort areas. While these strategies were effective in limiting resort development, the benefits of having mixed-use zoning have since been realized. Recent revisions to Waikīkī policy plans, which include the Waikīkī Special Design District, call for new development at the ‘Ewa end of Waikīkī, near the entrances to the neighborhood in an effort to create a livelier pedestrian environment and spur economic opportunities for new businesses.<sup>106</sup>

The Ala Wai Canal also presents a geographic barrier that hinders both mobility and accessibility. The Ala Wai Canal, marking the mauka and ‘Ewa edges of Waikīkī, is 2-mile-long, artificially constructed waterway built in the 1920s to drain nearby wetlands in preparation for urban development. As a result, Waikīkī is nearly entirely surrounded by this manmade aquatic barrier. And, nearly a decade later, people still rely upon three, vehicle-oriented bridges as the only access points into Waikīkī from the ‘Ewa end.

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<sup>106</sup> City Council, *Background Report: Revisions To Waikiki Special Design District* (Honolulu: The City and County of Honolulu, 2011), <http://c.ymcdn.com/sites/www.aiahonolulu.org/resource/resmgr/imported/WSD%20amendments%20background%20report%20and%20bill%2005-25-11.pdf>, 3-8.



Figure 14: Waikiki Zoning Map.

Source: Made By Author

Simply put, the lack of direct access across the canal is neither efficient nor pedestrian-friendly, and when provided the opportunity, most individuals would rather drive as opposed to walk, bike, or take the bus in order to access the opposite side of the canal. Furthermore, Kalakaua and Kuhio Avenues already support a high volume of automobiles daily, which not only adds to the already overly congested area, but also creates an unsafe environment for pedestrians. Overall, these issues run counter to visitor and resident expectations when traveling into Waikiki, and do not reflect Waikiki's reputation as a world-class, premier destination.<sup>107</sup>

<sup>107</sup> : *Waikiki Regional Circulator Study*, 127.



According to the city and county of Honolulu's Waikīkī Regional Circulation Study, providing a variety of pedestrian-oriented amenities and attractions for the purpose of continually enhancing the experience of walking in Waikīkī was consistently rated as one of the highest concept categories during stakeholder interviews and public workshops. Whether an individual is walking or driving, the path leading into Waikīkī remains at ground level; and with resorts, hotels, and shops all towering overhead, visitors are not fully able to enjoy the unique landscape and visual character that accompany Waikīkī's exclusive coastline location. Furthermore, this is where the potential for a more experiential method of travel comes into play: ART would create views for anyone traveling into Waikīkī that would otherwise be unavailable at ground level, thus allowing Waikīkī to take full advantage of its geographic beauty. In order to retain its Hawaiian qualities and sense of place, as well as reinvigorate its economic vitality, Waikīkī needs to keep pace with its continuing urban transformation, evolving away from the vehicle congested atmosphere, and evolving toward a more appealing, attractive, and advantageous pedestrian-oriented environment that reflects the area's unique character.<sup>108</sup>

#### 4.3 UH Manoa

The next largest destination for riders traveling beyond the Ala Moana rail station is O'ahu's main university, The University of Hawaii at Manoa. UH Manoa's campus has a daytime population of over 30,000 affiliates, comprised of approximately 20,000 students and 10,000 faculty and staff, making it a major center for both education and employment. The University is centrally and conveniently located between a number of residential neighborhoods and urban Honolulu—uphill from Kaimukī, Waikīkī, and Ala Moana, all of which also fall within a three-mile radius of the university's main campus. The roadways that link these areas, however, are extremely vulnerable to heavy traffic congestion during rush hour periods.

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<sup>108</sup> : Ibid.

In addition to the University's campus grounds, various businesses and amenities located on University Avenue and King Street—an intersection also known as Pucks Alley—attracts many UH students off campus. Because Puck's Alley is in close proximity to the University, students typically commute to the intersection by walking, biking, skateboarding, or scootering. However, that particular intersection happens to be where three major arterial roadways—University Avenue, South King Street, and South Beretania Street converge, with a total of 29 different vehicle lanes, all of which cross through the intersection. Not only can such a busy and complex intersection be hazardous for drivers, and even more so for pedestrians, it also proves to be an important factor and ongoing issue, adding to the massive amounts automobile congestion in and around UH Manoa. Furthermore, the Stan Sherriff Center—a 10,300-seat multi-purpose arena frequently used to hold sporting events—as well as the other surrounding educational institutions including University Lab School and Mid Pacific Institute actively add to the area's density and high number of daily transportation trips.

#### *Overview of Transportation Behavior*

UH Manoa is commonly referred to as an urban commuter school, since a large majority of its students, faculty, and staff are living off campus and commuting to the university each day by car, bus, bike, walking, etc. According to UH Manoa's Campus Transportation Demand Management Plan, Oahu's linear corridor development pattern, driven by physical and topographical constraints, promotes longer commute patterns to the University and greatly influences mode choice," and approximately one-third of affiliates commute to UH Manoa's campus from communities on the western half of Oahu each day.<sup>109</sup> UH Manoa's Transportation Demand Management Plan shows that roughly 17% of all affiliates live within one mile of campus and within the walking catchment area, while 36% live within three miles from campus and within the bicycling catchment area.<sup>110</sup> Additionally, it was found that 43% of off-campus University affiliates drive to campus, while 48% of University affiliates access campus utilizing alternative modes of

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<sup>109</sup> *Campus Transportation Demand Management Plan*, report, University of Hawaii, April 27, 2016, accessed October 27, 2016, <http://manoa.hawaii.edu/planning/TDM2012.pdf>, 6-26.

<sup>110</sup> *Ibid.*, 5.

transportation including bus transit, the university shuttle, walking, bicycling, and/or carpooling.<sup>111</sup> However, the campus transportation survey did find that the majority of commuting affiliates are not devoted to one mode of transportation over another, further suggesting their prospective receptivity for a different and more efficient mode of transportation.<sup>112</sup> Overall, these are just some of the realities heavily contributing to the growing congestion, transportation-related challenges, and demand for more efficient campus access.

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<sup>111</sup> Ibid., 5.

<sup>112</sup> Ibid.

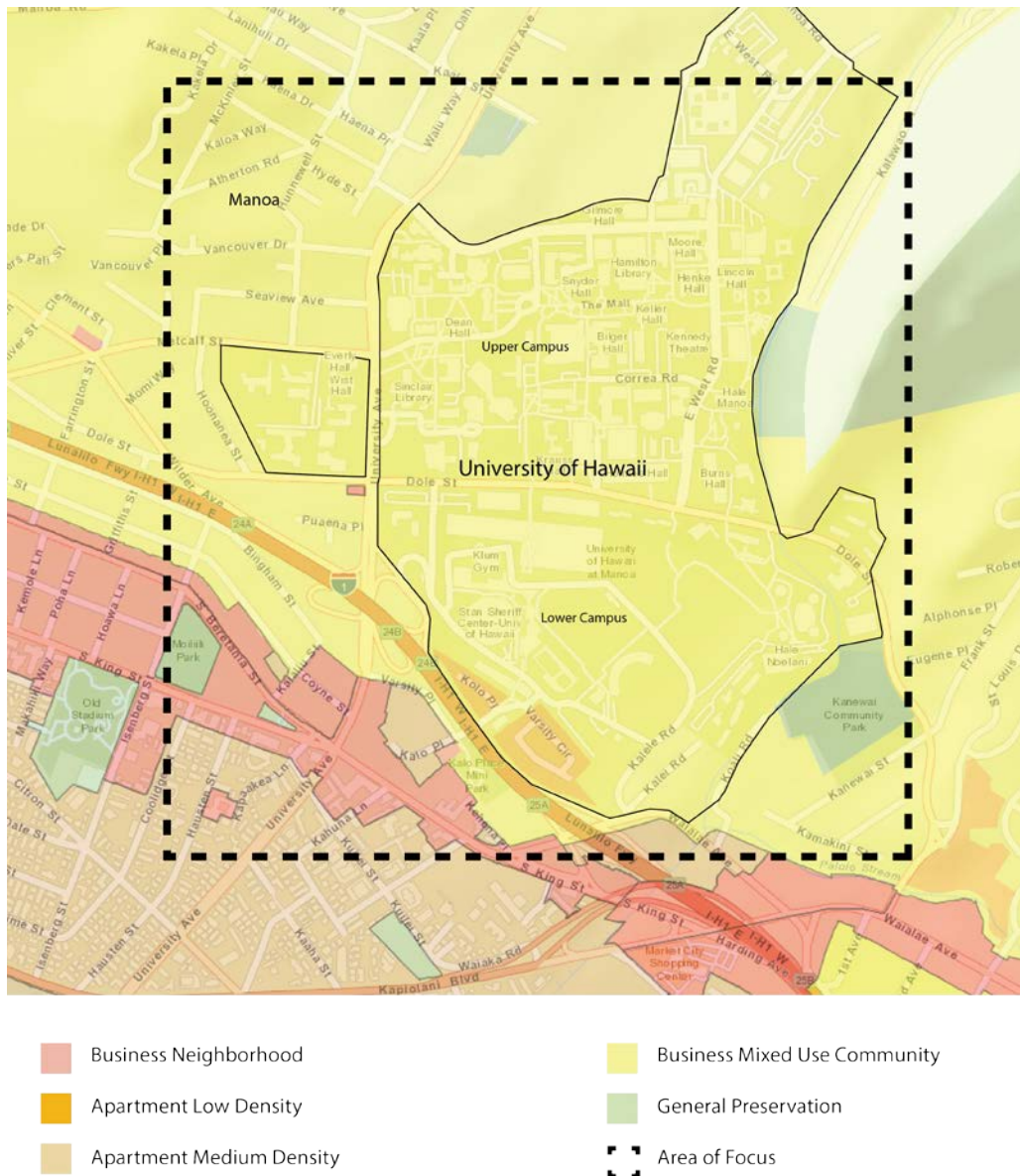


Figure 15: Ala Moana Zoning Map.

Source: Made By Author

The *Existing Conditions Report*, the *Campus Transportation Survey*, and their discussions with stakeholders and focus group participants formed the basis for key commute and transportation issues. Affiliates also provided behavioral and attitudinal information related to their commute experiences. To start, driving conditions in Honolulu were reported to be continually worsening; therefore, many respondents expressed a strong

desire for a more efficient transit system.<sup>113</sup> Although public transit has significant potential to shift trips from existing non-transit commutes, it has yet to do so. The University population reported substantial unmet demands for transit specifically regarding its lack of service quality along with its unaccommodating, inflexible trip schedules and routes.<sup>114</sup> A second transportation issue involves the unsafe bicycle and pedestrian environment in and around UH Manoa's campus. A majority of focus group participants reported feeling that neither UH Manoa nor the City itself has invested enough attention toward bicycle and pedestrian-oriented infrastructure. Affiliates expressed the need for safety while walking on campus and the need for low-stress bikeway connections that mitigate intersection conflicts and collisions with motorists<sup>115</sup>. In light of the numerous issues regarding transportation and access to the University's campus, UH Manoa does still "...[view] itself as having a fiduciary responsibility to expand access to education...as their primary business is education and ensuring people of all incomes, cultures, and backgrounds have access to those educational opportunities", which undeniably holds true with regard to the extensive work they put into creating the TDM plan.<sup>116</sup> Although the plan does suggest interim solutions, the University currently lacks the resources needed to construct the drastic and substantial changes required to effectively address the ongoing, growing transportation and campus access issues, all of which are projected to intensify over time as Oahu's population density continues to swell.<sup>117</sup>

Integrating an ART service station on the University of Hawaii at Manoa's campus, would not only provide University affiliates an alternate mode of transportation—one that is safe, reliable, comfortable, flexible, and schedule-accommodating, but it would also relieve much of the daily traffic and congestion caused by the high volume of cars driven to and from campus by commuting affiliates. As a result, there would be fewer cars on and around campus which would free up parking space, decrease the demand for more campus parking, as well as reduce pressure currently being placed upon the University to comply with demands they cannot afford. Furthermore, if an ART station were to be built on UH

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<sup>113</sup> Ibid., 8.

<sup>114</sup> Ibid., 9.

<sup>115</sup> Ibid., 10.

<sup>116</sup> Ibid., 5.

<sup>117</sup> Ibid.

Manoa campus grounds, it would allow for implementation of TOD planning, thus providing the University and its surrounding neighborhoods with some of the benefits that come along with implementing a TOD plan. These include higher quality pedestrian environments, improved bicycle paths, improved campus access, and restoration of a safe and pedestrian-oriented campus. Using ART as a catalyst for this development plan not only helps to address the University, its stakeholders, focus group participants, and 30,000+ affiliates' concerns and demands, but also presents comprehensive, long-term solutions for each of the outstanding issues, while simultaneously prevents some of these issues becoming more problematic in the future.

#### 4.4 Kaimukī

Although Kaimukī is known as one of Honolulu's oldest and most historic neighborhoods, it has a thriving local community. Kaimukī town is currently a lower-density residential area that surrounds a central corridor, otherwise known as Waialae Avenue. The *main street* portion of Waialae Avenue stretches from Kapahulu Avenue to 13th Avenue, and provides the town of Kaimukī with a wide array of established businesses, small shops and boutiques, and trendy new restaurants and bars, as well as some favorite, local eateries.

The development of Kaimuki and Waialae Avenue is unique. Kaimukī was originally developed by Gear Lansing & Co., one of O'ahu's early real estate developers, and was envisioned to be a high-class residential neighborhood, however, growth was initially slow due to low demand for housing in the area. Soon thereafter, the Honolulu Chinatown fire in 1900 drove business owners towards Kaimukī, and coupled with the development of the street car in 1903, the area quickly grew into a thriving community. Unfortunately, once the automobile began to proliferate, paved roadways – including the H1 Freeway – reduced the amount of pedestrian life along the street which devastated businesses as well as development interest in the area.<sup>118</sup>

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<sup>118</sup> June Watanabe, "Better Days," Honolulu Star-Bulletin Local News, April 24, 1996, accessed February 19, 2017, <http://archives.starbulletin.com/specials/Kaimukī/better.html>.

Even today, as the Primary Urban Center Development Plan states, “...older street-oriented business communities such as the Waialae Avenue corridor in Kaimukī...have declined,” and pedestrian use of the streets is little to none.<sup>119</sup>

Even with Waialae Avenue’s current surrounding area being mostly residential single-family and townhouse neighborhoods all within close walking distance of the corridor’s many amenities, Waialae Avenue has only a low-moderate active street life, mainly due to its lack of quality pedestrian and bicycle networks. Furthermore, Waialae Avenue now acts as a major thoroughfare for drivers traveling toward UH Manoa, Waikīkī, and Ala Moana, making the street much more vehicle-oriented than pedestrian-oriented, and in turn forcing many residents to rely on cars even when traveling short, walkable distances. And, as more people relying on cars as their preferred mode of transportation, it creates more traffic, heavier congestion, and longer commute times in Kaimukī, especially along Waialae Avenue.

The town of Kaimukī also falls within the designated Honolulu School District, promulgating itself as a significant school zone: inclusive of Chaminade University, Saint Louis School, Sacred Hearts Academy, Ali’iolani Elementary School, as well as a number of other popular neighborhood elementary and preschools. And, as many parents tend to send their child/children to a school near or within the district that also encompasses where they live; for Kaimukī Town, as well as for the majority of the other lower-density residential neighborhoods on Oahu, most students end up being driven to school because of Waialae Avenue’s absence of pedestrian and bicyclist-friendly networks.

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<sup>119</sup> City & County of Honolulu Department of Planning and Permitting, *Primary Urban Center Development Plan* (Honolulu: City & County of Honolulu Department of Planning and Permitting, 2004), 3-22.

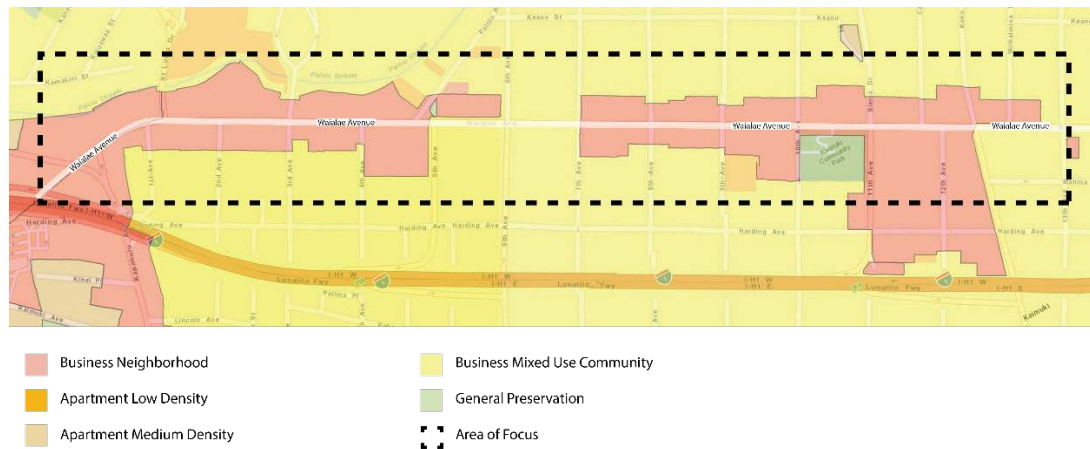


Figure 16: Waialae Avenue Zoning Map.

Source: Made By Author

In 2001, a Kaimukī Traffic Calming Master Plan was proposed in order to readjust the town’s focus away from automobiles, and toward pedestrian-friendly development—further emphasizing the idea of the pedestrian being central to the success of a traditional urban center. And, although Waialae Avenue has seen commercial interest in recent years—with the neighborhood managing to retain its historical island charm whilst making room for new business growth—Kaimukī is still not reaching its full potential both economically and socially.<sup>120</sup>

In order to cultivate existing neighborhood centers, neighborhoods must develop a central place where people can gather for shopping, entertainment, and recreation; all of which entails investment in parks and pedestrian street improvements. In addition, “cultivating livable neighborhoods involves reintegrating commercial and residential uses within neighborhoods; making streets safe and pedestrian-friendly; redeveloping certain streets to attract pedestrian-oriented commercial activity; and creating parks and urban open spaces that attract people for informal recreation and socializing,” all of which is best accomplished through collaborative planning.<sup>121</sup>

Overall, the area along Waialae Avenue has a great potential to improve, both economically and socially. Bringing ART into Kaimukī would not only serve to address

<sup>120</sup> Ibid., 7.

<sup>121</sup> Ibid. 32- 60.



some of the long-standing needs for developing a balanced transportation system in the area, but it would also allow for implementation of transit-oriented development practices within Kaimukī. With improved pedestrian access and a unique way of traversing along Waialae Avenue, the area could potentially become a more vibrant and pleasant environment for residents and visitors alike.

## 5.0 Transit Network Overview and Analysis

As an island with nearly 1 million people, there are a high volume of transit commutes made every day. It is estimated that approximately 3.2 million commutes are made on a daily basis during the average work week. Approximately 86% of these commutes are made by local residents, with 34% of these trips either originating or ending at a place of work. The remaining 14% of trips are reportedly made by visitors and some commercial trucks.<sup>122</sup> In order to understand where and how to best integrate the ART route, as well as locate the station terminals within these historically and culturally rich areas, there needs to be thorough understanding of the existing transportation modes and movement patterns. Because this project proposes integrating a new method of public transit within an already heavily developed area, both weaknesses and opportunities within the existing multi-modal transit system must be identified to properly justify an aerial ropeway in Honolulu. This section provides a summary and analysis of the current and future transportation elements within Honolulu.

### *Infrastructure*

Oahu's vast and complex transportation network consists of roadways, highways, freeways, and rail—the last of which is currently under construction. The major elements that operate on these transportation arteries include pedestrians, bicyclists, automobiles, and public transit systems. Larger infrastructure such as freeways and rail guideways are often elevated above-grade, and are responsible for supporting the high number of riders traveling longer distances in order to arrive at their destinations. Highways and roadways are located at-grade and act as sub-arteries, are are considered to be circulating pathways for lower volumes of people within more dense urban areas. Because each have their own unique characteristics, restrictions on speed and allowable mode of transit are set in place to maintain safety and efficiency. Roadway rules, maintenance, and overall performance is regulated by both the City of Honolulu and the Hawaii Department of Transportation.<sup>123</sup>

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<sup>122</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3, 8-10.

<sup>123</sup> *Ibid.*

## 5.1 Rail

The newest addition to the transit network, currently under construction, is the high-capacity rapid transit rail project. Oahu's "General Plan" has directed both population and employment growth to areas between Kapolei and East Honolulu. However, new development and population growth has greatly slowed the efficiency of Oahu's existing roadway infrastructure. Consequently, the rail project is first and foremost a response to this issue. While the project does not intend to fully mitigate congestion, it aims to provide priority toward moving people, instead of moving large volumes of automobiles.<sup>124</sup> The initial route is proposed to span 20 miles, and have 21 stations along O'ahu's southern coast between major population centers such as East Kapolei near the University of Hawaii West Oahu Campus, the Leeward Community College, Pearl City, Pearlridge, Aloha Stadium, Salt Lake, Kalihi, Honolulu Community College, downtown Honolulu, Kaka'ako, and Ala Moana Shopping Center.

As mentioned, the first major benefit to the new rail project is its ability to provide a more efficient method of transit between urban destinations around the island. While rail will not eliminate traffic, it is projected to lessen the effects of congestion. The Rail *Environmental Impact Statement* report defines three basic traffic categories when quantifying the overall traffic benefits rail will provide individuals: the changes in Vehicle Miles Traveled (VMT), the changes in Vehicle Hours Traveled (VHT), and the changes in Vehicle Hours of Delay (VHD).<sup>125</sup>

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<sup>124</sup> Ibid., 3-4.

<sup>125</sup> Ibid., 3-6.

**Vehicle miles traveled (VMT)** equals the number of trips using a roadway multiplied by the facility's total length in miles.

**Vehicle hours traveled (VHT)** equals the number of trips using a roadway multiplied by the travel time for each travel period.

**Vehicle hours of delay (VHD)** equals the difference between the congested VHT and the VHT that would be expected under free-flow conditions.

Figure 17: Rider Benefit Measurements - VMT, VHT, and VHD

Source: Rail EIS, Chapter 3<sup>126</sup>

According to the figure below, 2030 projections forecast that without rail, VMT will increase 21% to 13.6 million miles, VHT will increase 28% to 415,600 hours, and VHD will increase 46% to 104,700 hours each day, throughout the entire roadway network, when compared to current levels recorded in 2007. These numbers are significantly reduced when compared to a full build-out of the rail in 2030. With a full build-out of rail, VMT will increase 16% to 13 million miles, VHT will increase 18% to 282,800 hours, and VHD will increase 19% to 85,800 hours. Therefore, Rail is projected to provide a substantial decrease for these measures, especially for VHD, highlighting the fact that a small decrease in traffic volumes can substantially reduce overall delay hours for all drivers.<sup>127</sup>

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<sup>126</sup> VMT, VHT, and VHD, Screen capture, *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, 3-6.

<sup>127</sup>The City and County of Honolulu, *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3, 9-10.

Alternative	Daily VMT	Daily VHT	Daily VHD
2007 Existing Conditions	11,232,400	325,700	71,800
2030 No Build	13,623,100	415,600	104,700
2030 Initial Rail Project	13,049,000	383,800	85,800
% Change From No Build	-4%	-8%	-18%

Table 2: Overall Benefits from Rail in Hours Traveled, Miles Traveled, and Delay.

Source: Rail EIS, Chapter 3<sup>128</sup>

Another positive aspect to rail is the increased user benefits for a greater number of individuals across the island. User benefits, as defined by the Rail EIS, is quantified into a standard unit measurement and encompasses four main goals: improved mobility, reliability, access to planned development, and transportation equity. After different rider markets were analyzed, it was determined that the number of benefits serving individuals across the island are nearly double in comparison to a no-build scenario. Depicted in the figure below, areas with people who are highly dependent on public transit, using it to travel between work and live destinations each day, will receive greater benefits from the project. These neighborhoods include Waikīkī, Ala Moana, Kaka’ako, Downtown Honolulu, Chinatown, Iwilei, Kalihi, ‘Aiea, Pearl City, and Waipahu.<sup>129</sup>

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<sup>128</sup> Ibid.

<sup>129</sup> Ibid., 38.

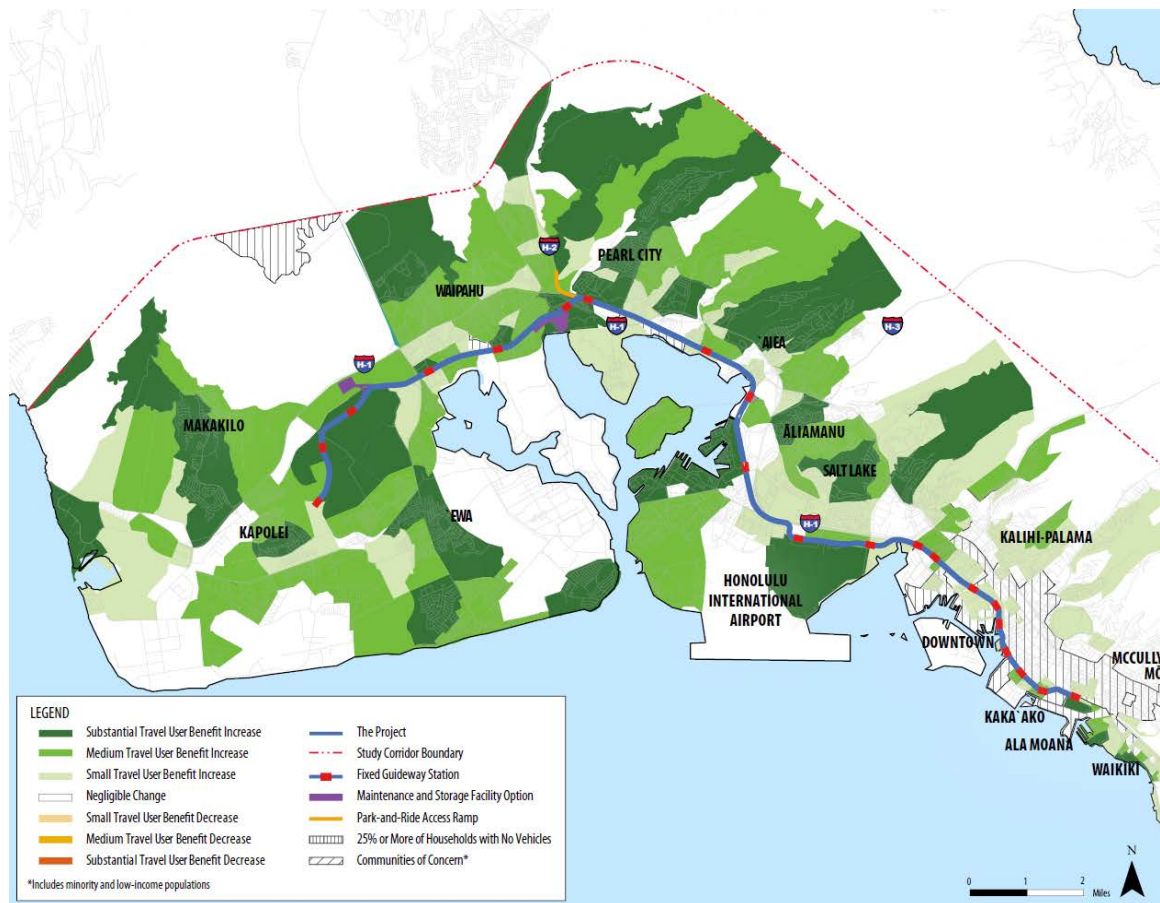


Figure 18: Map of transit dependent households and areas of greatest benefits.

Source: Rail EIS, Chapter 3<sup>130</sup>

### *Drawbacks*

Although O‘ahu’s rail project provides significant benefits to its residents, the project has numerous drawbacks which have been deeply divisive amongst legislative figures and the public. One challenge the project faces, is that limited resources require rail to terminate at Ala Moana Shopping Center, leaving some of Honolulu’s major urban nodes including Waikīkī–Oahu’s tourism center–and the University of Hawaii at Manoa–the state’s primary public university–completely disconnected. Original transit plans introduced in 1967 proposed a route that passed through Waikīkī and The University of Hawaii at Manoa, and then continued into Hawaii Kai. Though the initial route fell short of several destinations, future plans aim to build guideway extensions to reach critical

<sup>130</sup> Ibid., 32.

employment and residential centers beyond Ala Moana. Unfortunately, consideration and funding for the project will not likely happen until much later, after the initial route is completed in 2021, leaving several of Honolulu's critical neighborhoods in disconnection.<sup>131</sup>

As part of the rail project's success will be measured by transit ridership, segregating areas such as Waikīkī, Manoa, and Kaimukī presents a missed opportunity for individuals demanding quick and convenient transit to and from these locations. Ignoring a significant portion of the transit ridership market could undermine the project's utility, and potentially erode public and legislative support for future extensions.<sup>132</sup>

Another major challenge with the rail project has been that cost overruns and extends completion dates. Original financial estimates projected rail to cost approximately \$5.2 billion, to be funded by both city and federal funds, and to be fully completed by March 2019.<sup>133</sup> A 2015-2016 audit of the Honolulu Authority for Rapid Transportation (HART), done by the City and County of Honolulu, found that construction setbacks, increased site work, and legal issues, amongst other unexpected challenges, had increased the project's overall cost to exceed \$8 billion, delaying the completion date to late 2021. While setbacks are common for major infrastructure projects, rising costs are limiting design and preventing the project from reaching its intended goals.<sup>134</sup>

Because of the system's infrastructure size and the nature of implementation through existing development, property acquisition requires approximately 14,500,000 square feet of private and government property in order to construct the initial rail route (HART Acquisition 2015). Furthermore, much of the land requirements are needed for the construction of the support pylons that are frequently spaced under the concrete guideway, resulting in forced relocation for many businesses and residents.<sup>135</sup>

Aside from cost and construction, the overall infrastructure aesthetics are a major

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<sup>131</sup> Chad Blair, "Honolulu Rail Project News", *Civil Beat News*, 2016, <http://www.civilbeat.org/topics/honolulu-rail-project/>.

<sup>132</sup> Ibid.

<sup>133</sup> John Hill, "HART Raises Estimate For Total Cost Of Rail To \$8.6 Billion", *Civil Beat News*, 2016, <http://www.civilbeat.org/2016/09/hart-raises-its-estimate-for-total-cost-of-rail-project-to-8-6-billion/>.

<sup>134</sup> Edwin Young, Audit of the Honolulu Authority for Rapid Transportation, report (Honolulu, HI: City and County of Honolulu, 2016), v-vi.

<sup>135</sup> "Honolulu Rail Project", *Honolulu Civil Beat*, 2017, <http://www.civilbeat.org/topics/honolulu-rail-project/>.

point of contention. The massive nature of the system requires large diameter concrete pylons and a heavy concrete guideway that is elevated 50 feet above grade in certain areas. The visual impact left by the new system has attracted criticism from nearby residences and businesses as some ocean, mountain, and open sky views will be modified with a view of rail.

### *Future Plans for Rail*

The new rail system will be measured on its ability to efficiently provide greater urban access and integrate effectively into the current transportation network and existing urban fabric. Beyond the initial 20 mile route, future extensions are planned to further connect O'ahu's urban landscape. Though plans are in the early preliminary stages, an additional 14 miles and 12 rail stations are planned to be added the initial route. These route extensions will consist of new stations that aim to add West Kapolei, Salt Lake, Waikīkī, and UH Manoa to the guideway.

The extension into West Kapolei would continue off of the western end of the current project. The guideway is planned to extend along Saratoga Avenue, turning mauka along Kapolei Parkway, and terminating near Kapolei Commons—a major shopping and entertainment center in West O'ahu.

The extensions to Waikīkī and UH Manoa will continue from the easternmost end of the current project in Ala Moana. Due to existing development and high building density around the area, the current track will continue to terminate at the Kona Street station and a separate track would be constructed just West of Piikoi Street, that would climb over Ala Moana Shopping Center's existing parking garage. The elevated track would have an additional station platform for people at Ala Moana Center to transfer to a UH Manoa or Waikīkī bound train.<sup>136</sup>

The guideway bound for UH Manoa will continue along Kapiolani Boulevard then turn mauka and follow University Avenue, traversing over the H-1 Freeway until the route ends at a terminal station on the lower campus of the University. Possible intermediate platform stations would be located at Ala Wai Community Park and the intersection of

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<sup>136</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 2 (Honolulu: The City and County of Honolulu, 2016), 49.



University Avenue and King Street, an area with a high number of neighborhood amenities.<sup>137</sup>

The guideway leading toward Waikīkī will follow Kapiolani Boulevard and turn makai along Kalakaua Avenue. The route will then turn, traveling along Kūhīo Avenue and ultimately ending at a terminal station located at the end of Kapiolani Park, near the Honolulu Zoo. There will be an intermediate station platform at the Honolulu Convention Center for riders to transfer between the UH Manoa and Waikīkī guideways, as well as a stop along Kūhīo Avenue near the existing International Market Place.<sup>138</sup>

Because these urban nodes are considered major social and economic destinations, and have a high population density heavily dependent on public transportation, these route extensions are projected to increase daily ridership by another 28% when compared to the original route alone. Additionally, when considering the effects of congestion on highways and roadways, traffic categories VHD, VHT, and VMT will also be reduced.

## 5.2 The Bus

The main public transit system that serves Honolulu is an expansive bus system commonly known as the “TheBus”. TheBus is a very effective public transit system for the size and population density of O’ahu; and it was also noted that it is one of only 20 bus systems that operate in a city without any rail transit system. When rating its *load factor* (bus passenger trips vs. revenue hour), TheBus was rated 4<sup>th</sup>, behind San Francisco, Los Angeles, and New York.<sup>139</sup>

TheBus currently services more than 80% of O’ahu’s developed neighborhoods; and in 2015, there were approximately 468,531 weekly boardings, with 10% made by visitors. This system circulates throughout major transit arteries and acts as a thoroughfare to smaller roadways that access nearby neighborhoods, in order to provide maximum access to individuals. O’ahu’s public transit service covers 277 square miles, with over 100 routes, and 3,800 stops. These routes typically operate seven days a week, with bus stops

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<sup>137</sup> Ibid., 49.

<sup>138</sup> Ibid.

<sup>139</sup> Ibid.

frequently and strategically located along these different routes. It is estimated that 95% of O'ahu's urban residents live within a quarter-mile of a bus stop, which is within 10 minutes by foot.<sup>140</sup>

Due to O'ahu's numerous districts with varying geographies and population densities, there is a very complex roadway network already in place. Different buses operate on specific types of roadways to provide the most efficient means of circulating residents throughout the island. These route categories and functions are listed below:

- **Rapid Bus:** Includes routes City Express! And Country Express! These routes have less frequent stops and travel along major corridors between high density areas. They operate mainly during rush hour periods. City Express! A and B arrive every 15 minutes, while Country Express! arrives every 30 minutes.<sup>141</sup>
- **Urban Trunk:** Includes Routes 1, 2, 3, and 13. These buses arrive more frequently at stops and have direct routes along major 'Ewa and Koko Head within the Primary Urban Center (PUC). They arrive every 15 minutes or less.<sup>142</sup>
- **Urban Feeder:** Includes routes 8, 7, 6, 5, and 4. These routes run perpendicular to the coast line to service the neighborhoods along the hills and valleys. These routes connect back to the urban trunk and rapid bus routes.<sup>143</sup>
- **Suburban Trunk:** Includes routes 56, 55, 52, 42, and 40. These routes connect outlying communities back to the urban core. They usually arrive every 30 minutes.<sup>144</sup>
- **Community Circulator:** Includes routes 401 to 403, and 231 to 236. These routes only operate within specific neighborhoods to provide greater access for residents located in that area. These routes are also timed to connect passengers to routes leading to the urban core. They arrive every 30 to 60 minutes.<sup>145</sup>
- **Community Access:** These routes provide curb to curb access for passengers located

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<sup>140</sup> Department of Transportation Services, *Bus Fleet Management Plan* (Honolulu: City and County of Honolulu, 2008).

<sup>141</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016), 11.

<sup>142</sup> Ibid.

<sup>143</sup> Ibid.

<sup>144</sup> Ibid.

<sup>145</sup> Ibid.

within 0.25 miles of the route and uses the *Handi-Van* vehicles. This service arrives every 60 minutes.<sup>146</sup>

- *Peak Express*: The peak express bus route is used to serve home to work trips during rush hour periods. They usually connect high density neighborhoods to prominent employment centers.<sup>147</sup>

### *Bus Transit Drawbacks*

While these different routes aim to provide the most efficient public transit system possible within the constraints of Honolulu's roadway infrastructure, TheBus does have several drawbacks that limit its proficiency in transporting passengers both quickly and efficiently.

The first drawback of public transit by bus, is its overall slow transit speed. By nature, buses operate at a much slower pace than automobiles and other motorized vehicles, as their larger size causes them to accelerate, decelerate, and travel at slower speeds. And depending on their route and capacity, buses can range from 40 to 60 feet in length.<sup>148</sup> One of the major reasons for their slow speed, is that buses are subject to using the same roadway networks as other vehicles. As a result, they are required to follow the same roadway regulations such as speed restrictions, traffic signals, and other physical roadway conditions that slow traffic and cause congestion in high density urban areas. According to the Rail EIS, bus speed for major urban routes has slowed considerably over the last 25 years, resulting in longer overall transit times.<sup>149</sup>

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<sup>146</sup> Ibid.

<sup>147</sup> Ibid.

<sup>148</sup> Department of Transportation Services, *Bus Fleet Management Plan* (Honolulu: City and County of Honolulu, 2008).

<sup>149</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016).



Figure 19: The Bus Operating Speed by Year.

Source: TheBus 2012<sup>150</sup>

The figure above shows a modest, but steady decline in the overall operating speed of bus transit from 1984 to 2009—the period over which this data was recorded.

Recognizing the rapid growth in development and population on O’ahu, the city has been well aware of the declining performance of TheBus. In an effort to reduce the number of cars and combat the slow transit times, a major restructuring of bus routes was conducted in 2001. The new system was deemed the “Hub and Spoke Network” comprised of focused bus stop transition nodes known as “hubs,” and new routes known as “spokes.” Where previous bus stops served few routes with limited destinations, the new system strategically redefined prominent bus stops as hub centers to provide more connection routes, thus broadening access to more destinations. Though a slight improvement in operating speed during this period can be seen in the table above, the increasing congestion on roadways continued to slow bus operating speeds. Though this particular graph does

<sup>150</sup> “Waikiki Regional Circulator Study”, report, Department of Transportation Services, 38.

not show speeds past 2009, it illustrates that bus speeds reached a low of 13.2 miles per hour in 2007.<sup>151</sup> Though efforts to improve speed and efficiency are continually made, monthly statistics on ridership and performance published by TheBus has continued to report that operating speeds have steadily declined every month. Average bus speeds in 2016 were reported to be at 12.8 mph, with speeds dropping to a projected 12.6 mph in 2017.<sup>152</sup>

Another drawback of the bus is its high vulnerability to delays. The bus transit measures its reliability through the ability to arrive on schedule to its destinations. It is considered late if a bus arrives later than five minutes past its scheduled time. The Rail EIS used a level-of-service standard to rate O’ahu’s bus system on a grade scale, from “A” being the best, to “F” being the worst. Honolulu’s bus system was rated “F” due to its poor schedule reliability. From 1998 to 2007, during which this study was conducted, roughly 30% of all buses had unreliable arrival times. The rail EIS stated that in some circumstances, when buses are considerably late, the bus drivers are instructed to abandon their full route and unload all passengers at the current stop, allowing that bus’s next scheduled route assignment to start on time.<sup>153</sup>

There are numerous causes for bus delay depending on the area, route, and rider demographics. The first major cause of delay for buses is general congestion. As mentioned previously, buses use the same roadway network as every other motorized vehicle; and because of this, they are subject to high volumes of automobiles during both peak and off-peak rush hours. Traffic controlled intersections, vehicle queues, pedestrians in crosswalks, and blocked bus stops are all factors that contribute to delays and ultimately poor schedule reliability.<sup>154</sup>

Another common reason for delay is passenger loading time. Depending on the location and destination of the bus route, passenger loading times can cause major delays in scheduling. One of the main reasons for delayed loading times is due to high passenger

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<sup>151</sup> “Waikiki Regional Circulator Study”, report, Department of Transportation Services, 27.

<sup>152</sup> TheBus, *Monthly Performance Report*, August 2016 (Honolulu: Oahu Transit Services, 2016), [http://www.thebus.org/Performance/Performance\\_Bus.asp](http://www.thebus.org/Performance/Performance_Bus.asp).

<sup>153</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016).

<sup>154</sup> “Waikiki Regional Circulator Study”, report, Department of Transportation Services (Honolulu, HI: Weslin Consulting Services, 2013).

usage. When routes are heavily used, large numbers of passengers can queue at bus stops, resulting in longer boarding times, especially when buses are already crowded. Furthermore, if greater access is needed for disabled passengers, the driver assists in deploying a wheelchair ramp which can also increase delay. Another form of passenger delays is caused by passengers asking the bus's driver questions. This can cause delays because the passengers sometimes block entry to other riders attempting to board the bus. This usually occurs in areas with a high visitor demographic, such as Waikīkī and Ala Moana, where riders are unfamiliar with the city. Although routes and destinations are posted on bus stop signs, as well as on the web, this information is sometimes criticized as being confusing and unintuitive to infrequent riders.

#### *Future Plans for TheBus*

The new guided rail system will heavily affect the ridership patterns on O'ahu. In response to this new infrastructure and development, the city plans to strategically restructure many of the buses along the rail corridor in order to provide the most efficient means of public transit possible. The main goal is to create a safe and intuitive transition experience for passengers when switching public transit modes between rail and bus. The city plans to relocate many bus stops adjacent to and/or near the new rail stations in the form of on-street or off-street facilities, where riders can exit the train and transfer to different destinations by bus.<sup>155</sup>

Operation hours will remain the same, however many routes will be altered to provide access near rail stations. Major locations of restructuring will occur in areas that are less developed, especially in West O'ahu. Waianae and East Kapolei will have the biggest changes along with areas in central O'ahu. Due to high density and mature development in areas such as downtown, Ala Moana, and Waikīkī, some routes will be altered. However, they will continue to operate on primary transit arteries such as Ala Moana Boulevard and Kapi'olani Boulevard.

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<sup>155</sup> City and County of Honolulu Department of Transportation Services, *Honolulu Urban Bus (HUB) Circulator System* (Honolulu: City Council, 2016).

### 5.3 Private Automobiles

Like the rest of the United States, driving by private automobile is the most preferred mode of transportation on O’ahu. Driving is heavily intertwined within American culture, as much of the urban environment, along with its roadway network, was developed to accommodate automobile accessibility. The benefits private automobile transportation include the freedom to travel anywhere along the roadway network without needing to adhere to departure schedules and/or route transfers. Individuals enjoy the benefit of privacy, higher traveling speeds, freedom to make multiple stops along a route, as well as a more direct route to their final destination. According to a 2007 study, of the nearly 2.8 million daily commutes made by residents on O’ahu, 82% of all daily trips were made by private automobile, with only about 6% made by public transit, and 12% made by bicycling and/or walking.<sup>156</sup>

#### *Drawbacks*

While these benefits are enticing, and continue to draw individuals towards automobile ownership, the growing drawbacks have been causing an increasing amount of issues. As mentioned previously, individual automobile ownership has been the main cause of congestion on the existing roadway networks. The Rail EIS reported that traffic volumes have risen considerably over the last several decades, and projected it to continue to steadily rise even with new rail infrastructure. Roadway congestion causes queues at intersections and overall slower speeds on highway and freeway infrastructure, ultimately causing drivers to spend an increasing amount of time in their cars each day.

Another major drawback is the lack of parking in and around destination centers. With thousands of automobiles traveling to and from similar nearby destinations during the same time period, places to park automobiles have become both limited and more expensive. Today, parking issues are more prevalent for both on-street and off-street

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<sup>156</sup> Ibid.

parking areas within the Primary Urban Center—including Waikīkī, downtown Honolulu, Kaka’ako, Ala Moana, and around the University of Hawaii in Mānoa.

Competitiveness for parking-stalls has also steadily increased the rate for public on-street parking. In 2011, all public parking costs were documented and it was estimated that the average daily parking cost for Honolulu was \$42. At \$25 higher than the national average, Honolulu’s parking rate is the highest in the country, ahead of the large cities such as downtown New York, Chicago, Boston, and Los Angeles.<sup>157</sup>

### *Future Automobile Ownership*

Automobile ownership and daily trips made by individuals driving alone is only projected to increase in the future. Though individuals recognize the environmental, economic, and health benefits of alternative transportation, automobile ownership is still expected to remain above capacity and steadily increase along with population and development projections into 2030 and beyond. When determining the need and feasibility for the new rail system, a full transit study was conducted to determine the current and future projections of the daily amount of transportation trips made by visitors and residents of O’ahu. Daily trip projections were determined for both building a new rail system and to a no-build alternative. In 2007, it was recorded that approximately 2,291,800 private automobile trips were made daily, which accounted for 82% of total trips made by O’ahu residents. For future projections, in 2030, daily trips made by private automobile owners after the full railway buildout is expected to rise to 2,761,800. In regard to projections for the no-build alternative, daily automobile riders are estimated to grow 2% higher, to 2,815,800. A full rail build-out is projected to slightly reduce the daily amount of trips made by private automobiles, in comparison to a no-build alternative. The total number of daily vehicle trips is expected to be reduced by 51,000, eliminating approximately 40,000 cars from the road. However, both scenarios predict a steady rise in trips made by private automobiles to volumes that would only further cripple the existing roadway transportation network.<sup>158</sup>

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<sup>157</sup> James Cook and Jeff Simonson, 2012 *“Parking Rate Survey* (Seattle: Colliers International, 2012), <http://www.lexpark.org/sites/default/files/pdf/ColliersParkingRateSurvey2012.pdf>.

<sup>158</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016), 40.



While visitors make up a smaller percentage of the total number of commutes made on island, their trips are much more centered around the Primary Urban Center (PUC), especially the Ala Moana and Waikīkī neighborhoods. It was estimated that roughly 11% total island commutes were made by visitors, totaling 364,400 trips. About 60,000 of these visitor trips originated in, or ended at Honolulu International Airport; and of those 60,000 trips, about 36% were made by shuttles, and 26% were made by private automobiles. Additionally, it was projected that more than 9,900 visitors are expected to use rail daily, 1,800 of which will use rail to travel to and from the airport.<sup>159</sup>

## 5.4 Bicycles

The development of O'ahu over the past several decades has favored the use of private automobiles as the primary mode of transportation, leaving infrastructure for bicycling to be nearly non-existent. Though as a city aimed to realign itself towards a greener and more accessible environment, Honolulu has seen a renewed interest in promoting bicycling as a form of alternative transportation.<sup>160</sup>

Due to the lack of bicycling interests during city planning, few bicycle pathways on O'ahu have their own infrastructure, which is why most bicyclists are forced to share the same roadway network as motorized vehicles. When describing bicycling pathways, there are three main categories: bicycle lanes, paths, and routes. Each have varying levels of safety, destination directness, and speed limits.

- **Bicycle Lanes:** These pathways share the same roadway network as other motorized vehicles. They are usually clearly marked along the roadway with distinctive paint, lines, and signage designating their use to bicycles only. These lanes usually range from four to six feet in width, therefore competing with automobiles for space along roadways.
- **Bicycle Route:** These pathways also use the same roadway network however they do not have space entirely dedicated to bicycle use. Bicycle routes share the same space with vehicles on roadways due to limited street space and are marked with roadway paint and

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<sup>159</sup> Ibid., 8.

<sup>160</sup> Helber Haster & Fee, Planners, *O'ahu Bike Plan - A Bicycle Master Plan* (Honolulu: Department of Transportation Services, City and County of Honolulu, 2017), <http://www.oahumpo.org/wp-content/uploads/2013/02/oahubikeplanaugust2012.pdf>.

signage to alert vehicles of bicyclists.

- **Bicycle Paths:** Unlike Bicycle lanes and routes, paths operate off of the roadway network and have little to no interaction with vehicles. They are commonly found in parks and other recreational areas, and are considered safer and more family friendly.

### *Existing*

Currently, O'ahu has approximately 132 miles of bicycle infrastructure and facilities comprised of these 3 pathway categories. Like the roadway network, bicycle pathways connect employment centers, educational institutions, and recreational destinations with residential neighborhoods. Pathways between destinations most often constitute a mixture of these routes, paths, and lanes in order to create direct and continuous access towards major destinations.

### *Drawbacks*

While there are considerable benefits to bicycling as a form of alternate transportation, quality, safety, and lack of bicycling infrastructure are common issues in many different areas on O'ahu. Development towards a vehicle-oriented environment has limited the ability for safe and continuous bicycling infrastructure along existing roadway, especially in more dense, urban areas. For example, some bicycle lanes and routes travel along roadways with heavy volumes of automobiles that typically travel at speeds higher than 40 miles per hour. Consequently, bicyclists are involved in numerous traffic accidents, many resulting in serious injuries and fatalities. In some areas of less developed neighborhoods, such as West O'ahu, bicycle infrastructure is often very narrow and discontinuous, also creating dangerous environments for bicyclists.

### *Future Plans for Bicycling Networks*

Studies have shown that many residents and visitors are interested in bicycling to and their destinations; however, the many drawbacks, discussed above, prevent them from doing so. Recognizing this need for stronger bicycling infrastructure, especially with the new rail guideway already well under construction, O'ahu city planners have begun to

implement strategies to improve and expand bicycle- and pedestrian-friendly networks.<sup>161</sup>

In 2012, the city set forth a plan to construct 559 miles of new bikeway facilities that more effectively integrates within the existing and projected transportation network over the next 20 to 30 years. This includes plans for better and more direct access to transit nodes, such as future rail stations and bus stops. Plans also aim to integrate bicycle parking areas at major transit points to promote the use of multiple modes of transportation. It is estimated that around 50% to 60% of the population would positively benefit from this plan as new facilities would have improved safety, provide better amenities, and allow greater accessibility and connectivity.<sup>162</sup>

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<sup>161</sup> Helber Haster & Fee, Planners, *O'ahu Bike Plan - A Bicycle Master Plan*, 1-11

<sup>162</sup> Ibid.

## 6.0 Analysis of Connections

Waikīkī, Kaimukī, and the University of Hawai‘i at Mānoa—all of which lie East of Ala Moana—each have their own unique character that contributes heavily to the sense of place on the island of O‘ahu. The high concentration of jobs, schools, households, and amenities make these locations some of the most traveled-to areas on the island; therefore, it is important that the transportation behavioral patterns between these areas be fully understood. Only by understanding and addressing the associations between pedestrians, bicyclists, mass transit, automobiles, and aerial gondolas can an effective transportation and development strategy be implemented to strengthen the relationships between the built environment and its surrounding community.

Since transportation is one of the most critical components to daily life in Honolulu, it is closely monitored and recorded each and every day, especially during peak rush hour periods. These records then help transportation planners and city planners to analyze and understand transportation behavior patterns within the city. Additionally, the records allow them to sustain and improve fluid movement within the city in a safe and efficient manner. As a result, the city has funded several transportation and infrastructure studies that address present and future issues such as access, mobility, and reliability via the application of census data, on-site observation studies, community stakeholder meetings, and computer data models.

Data from these existing reports—such as current and projected daily trips made, the purpose of trip, and the chosen mode of transit—are used in this chapter to establish whether a substantial market exists for ART. In addition, this section analyzes specific existing and projected travel behaviors between these destinations to better comprehend how ART can strengthen the transit network in the future, whilst identifying where weaknesses lie within the existing circulation network.

- Connection 01: Between Ala Moana Shopping Center and Waikīkī
- Connection 02: Between Ala Moana Shopping Center and UH Mānoa
- Connection 03: Between UH Mānoa and Waikīkī
- Connection 04: Kaimukī to Ala Moana, Waikīkī, and UH Mānoa

## 6.1 Summary of Neighborhood Destinations

### *Ala Moana:*

As the state's largest commercial destination, the center attracts more than 48 million resident and visitor shopping trips per year, accumulating more than \$1 billion in yearly sales. Ala Moana Center, along with its surrounding area, is designated for commercial development, and has approximately 290 diverse businesses including many local retailers and eateries. As Ala Moana Center has continued to see rising profits due to higher population growth and an increase in tourism, both the shopping center and surrounding area have seen significant expansion and development over the past decade. In 2014, a 23-story luxury condominium tower was completed. In 2015, a major expansion and redesign of the mall's west wing was unveiled, further increasing the overall number of businesses within the center. And today, seven, 8-story luxury condominiums are under construction on the ocean side of the mall. <sup>163</sup>

The Ala Moana Shopping Center will also be the final terminus for the rail project along Oahu's southern coast. As a major economic center with a high concentration of employment in and around the area, transit projections estimate 22,610 people—consisting of mainly residents traveling to and from work or school—are expected to arrive and depart the station daily.

### *Waikīkī:*

The second major destination, located less than a mile from Ala Moana Center, is Waikīkī—O'ahu's primary tourist destination. Waikīkī covers approximately one square mile of shoreline and contains a dense environment of high-rise hotel towers, apartments, restaurants, and businesses; the majority of which are catered towards visitors and residents alike. Historically, the area has been an international travel destination due to its pristine beaches, unique landscape, and shopping destinations. And due to its steady growth, Waikīkī has quickly become a modern urban center.

In 2015 O'ahu alone saw 8,563,018 domestic and foreign visitors, with 81,782

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<sup>163</sup> City and County of Honolulu, *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016)., 3-45.

people visiting Waikīkī daily. Future projections indicate that the annual visitor number will increase to 9,355,000 by 2019. Projections also indicate that Waikīkī's population will rise to 22,900 people, and jobs in the area will rise to 49,100. While the total number of daily transportation trips made to and from Waikīkī is already considered to be high; a growing population, rising employment opportunities, and a nearby train station will only further increase the number of trips.<sup>164 165</sup>

*University of Hawai'i at Mānoa:*

The next biggest destination for riders traveling beyond the Ala Moana Rail Station is the University of Hawai'i campus in Mānoa. The Mānoa campus has a daytime population of approximately 20,000 students. When including the extension courses and continuing education programs, the campus has an enrollment of nearly 50,000 people, in addition to the 10,000 faculty and staff that work on campus. Other educational institutions surrounding UH Mānoa greatly add to the area's density. University Lab School and the Department of Education are located adjacent to UH Mānoa on University Avenue; while Mid-Pacific Institute is located mauka of UH Mānoa along University Avenue. The lush backdrop, as well as its central location within East Honolulu, attracts a large portion of transportation trips East of Ala Moana Center, emphasizing the need for transportation analysis within the area.

*Kaimukī - Waialae Avenue:*

Located east of UH Mānoa and mauka of Diamond Head, is Kaimukī—one of the last remaining historic neighborhoods in Honolulu. The area is approximately 1.9 square miles and is mostly comprised of older, single family homes and low-rise, mixed-use buildings that line Waialae Avenue—Kaimukī's main street and town center.

While the historic homes and businesses provide Kaimukī its charm, attracting both visitors and nearby residents; Kaimukī—more specifically the area around Waialae Avenue—is an important location and destination within East Honolulu because many of

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<sup>164</sup> City and County of Honolulu, *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016)., 3-45.

<sup>165</sup> City and County of Honolulu Department of Transportation Services, *Honolulu Urban Bus (HUB) Circulator System* (Honolulu: City Council, 2016), 4.

the residents and visitors utilize Waialae Avenue both as a growing leisure destination and a major arterial roadway. Currently, Waialae Avenue has a mix of new and old restaurants, retailers, and shops that many people enjoy visiting. Though the neighborhood can at times seem tired and/or sleepy, recent economic interest in the area has begun to breathe new life along Waialae Avenue in the form of new businesses, building renovations, and infrastructure improvements. However, while the area has seen significant improvement, it lacks qualities that allow it to reach its full potential. The most obvious issue is that Waialae Avenue serves as a major roadway: it provides access to the surrounding neighborhoods, while experiencing high volumes of vehicular traffic during the day, and in the evening—as many Kaimukī households begin and end their daily commutes traveling along this thoroughfare. Therefore, Kaimukī’s *main street* is a heavily utilized economic corridor whose early design and planning has led to a charming town center where, unfortunately, pedestrians and automobiles clash: ultimately resulting in a cultural neighborhood that is unable to reach its full social and economic potential.

### *Overall*

These historical, cultural, and economically unique locations within the city have collectively shaped Honolulu into the city it is today. However, it is important to recognize that population, development, and employment opportunities will increase in these areas, while, unfortunately, the capacity for vehicles will most likely remain the same. Therefore, this issue must be addressed; especially since the city’s population, both now and in the future, will need to be able to rely on public transit as circulation slows down. The tables below provide a snapshot of population and employment growth projected through to the year 2030. Overall, the data represented in these tables reflects moderate to extreme growth throughout these locations, only further emphasizing the importance of strengthening the current lack of connectivity between them, and improving access through the implementation of ART.

Area	2000	2030	% Increase
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Waikīkī	20,700	22,900	11%
Ala Moana - Moilili	39,500	48,800	24%
Makiki-Mānoa	44,300	47,700	8%
UH Mānoa	5,900	6,100	3%
Kaimukī-Waialae	55,000	57,800	5%

Table 3: Population Growth by Transportation Analysis Areas

Source: Rail EIS Chapter 01 <sup>166</sup>

Area	2000	2030	% Increase
Waikīkī	44,900	49,100	9%
Ala Moana - Moilili	40,100	48,600	21%
Makiki-Mānoa	7,100	9,200	30%
UH Mānoa	12,600	13,500	7%
Kaimukī-Waialae	19,600	24,100	23%

Table 4: Employment Growth by Transportation Analysis Areas

Source: Rail EIS Chapter 01 <sup>167</sup>

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City and County of Honolulu, *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 1 (Honolulu: The City and County of Honolulu, 2016)., 10.

<sup>167</sup> Ibid., 11.



## 6.2 Connection 01: Ala Moana Shopping Center and Waikīkī

Ala Moana and Waikīkī serve as two of the most traveled-to destinations on the island. As major economic centers in Honolulu, there is a high population of both visitors and residents traveling between them. Residents in particular, primarily travel between these destinations to go to and from work, while visitors travel between these destinations for the pristine beaches, shops, and eateries. Thus, the arterial roadways that link these destinations are heavily used by all modes of transportation. The main roadways connecting these destinations include: Kapi‘olani Boulevard, Ala Moana Boulevard, McCully, Kalakaua Avenue, Kūhīo Avenue, and both eastbound and westbound directions along Ala Wai Boulevard.

### *Bus Transit:*

Public transportation by bus is one of most heavily used methods of transit between Waikīkī and Ala Moana, especially due to the high density neighborhoods along these major access routes and activity centers.

Currently, bus transit trips in these neighborhoods are two of the top twelve key transit markets on Oahu. This is due to high ridership volumes of residents traveling to and from work, as well as visitors traveling between neighborhoods for shopping, leisure, and/or entertainment. According to the *WRTS/RAIL* Environmental Impact Study, the largest portion of all public bus transit on Oahu originates in Waikīkī and the surrounding neighborhoods. Although these statistics do not include visitor transit on trolleys and private tour buses, transportation studies estimate that both methods of transit do indeed circulate a high volume of visitor passengers between these destinations.<sup>168</sup>

The main bus routes that operate along these streets include bus routes 8, 20, 23, and 19, with additional routes W3 and 42, as well as those serving on weekends and during peak rush hour periods. Furthermore, it was identified that bus route 8 is the only route that operates solely between these two destinations. Route 8 and 23 start at Ala Moana and loop through Waikīkī, while bus 19 and 20 travel by Ala Moana Center on Kona Street when traveling east, as illustrated in the figure below.<sup>169</sup>

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<sup>168</sup> Waikiki Regional Circulator Study, report, Department of Transportation Services (Honolulu, HI: Weslin Consulting Services, 2013).

<sup>169</sup> Ibid.

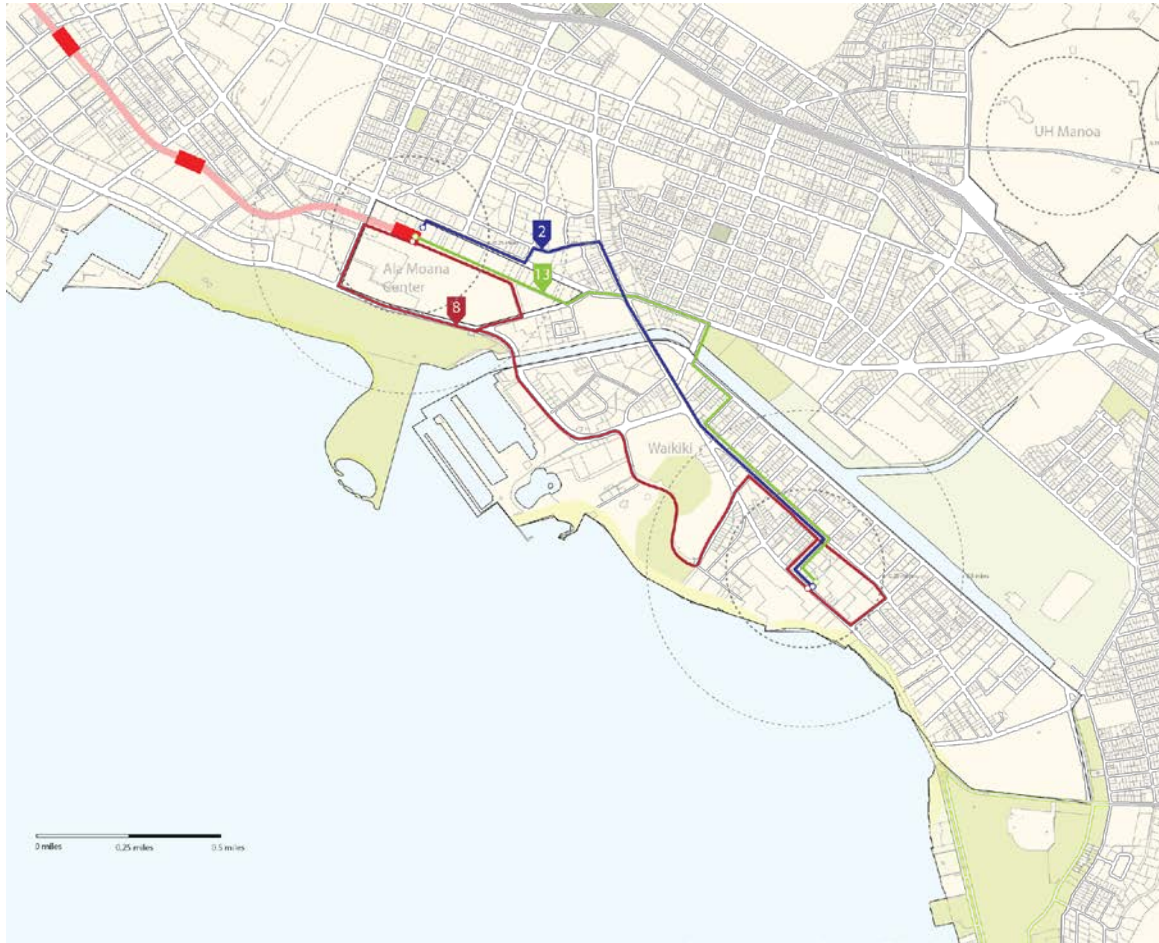


Figure 20: Quickest and most direct bus routes between Ala Moana Center and Waikīkī  
– Routes 8, 13, and 2  
Source: Made By Author

Even though bus transit between these routes can successfully provide a safer, cheaper, and more environmentally friendly method of transportation between destinations; bus transit operating between these destinations are vulnerable to a number of observed drawbacks. The first drawback of the Ala Moana to Waikīkī bus transit connection is that these routes, like every other mode of transportation, circulate on heavily congested roadways. High volumes of vehicles, bicyclists, and pedestrians all sharing narrow roadways, along with the traffic and increased signage, only creates a longer commute time; especially with the continual growth and development of these two

destinations. Furthermore, bus transit receives little to no preferential treatment when moving through traffic, as they must adhere to the same traffic signals and lanes as individual vehicles. Due to their extremely large size, their slower speeds, and their low maneuverability, buses are subject to overcrowding and blockage; especially when taking into consideration the bus stops along Kapahulu and Kūhīo Avenue in Waikīkī, and those located along Ala Moana Boulevard and Kona Street near Ala Moana Center—all of which have only gotten worse due to the more recent rapid development and rising population within these areas. For instance, traffic signals—which all buses are required pass through—have doubled to 48 since 1972, indicating a steady increase in roadway complexity with little to no increase vehicular capacity.<sup>170</sup>

Operating in complex and congested traffic has also resulted in the slow operating speeds of Waikīkī and Ala Moana bus transit. When comparing bus speeds for all major bus routes on the island, it was found that those routes traveling to either Waikīkī or Ala Moana had the slowest operating speeds throughout the overall bus transit network. Route 8, for example, travels the shortest and most direct path between Waikīkī and Ala Moana. However, a 2012 Waikīkī Regional Circulator Study revealed that this route had an average operating speed at 6.5 miles per hour, which is much slower when compared to other buses operating on the island. And because travel speeds are the slowest when operating between these areas, long commute times have become a lingering issue.<sup>171</sup>

Passengers traveling along these major roadways are spending longer periods of time on the bus. Additionally, the time it takes to travel between these destinations are also increasing with slower travel speeds and more congested roadways. During peak periods of transit use, it can take a passenger traveling from Ala Moana to Waikīkī a total of 31 minutes just to go a mere three miles. And, a passenger must wait nearly the same amount of time when traveling in the reverse direction from Waikīkī to Ala Moana.<sup>172</sup>

One of the major causes for longer commute times—specific to these connecting routes—is the delay times caused by passengers. The Waikīkī Traffic Study reported that

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<sup>170</sup> *Waikiki Regional Circulator Study*, report, Department of Transportation Services (Honolulu, HI: Weslin Consulting Services, 2013).

<sup>171</sup> *Ibid.*

<sup>172</sup> “Honolulu, HI” Google Maps. Accessed March 1, 2016. <https://www.google.com/maps/@21.2917045,-157.7914041,15z>

Waikīkī routes experience higher than normal passenger delay times primarily due to the passengers frequently asking the bus driver questions about their route. This occurs much more frequently in areas with a higher visitor population because riders are not only unfamiliar with the city, but also with the roadway network. Furthermore, in 2013, Waikīkī had approximately 6,000 visitors use bus transit from Waikīkī to Ala Moana Shopping Center daily, and that number is expected to continue to rise into 2030.<sup>173</sup>

However, majority of the visiting passenger's questions can be attributed to their lack of ability to navigate the city, as it is difficult for both visitors and resident to find, as well as rely upon posted route schedules, maps, and arrival times. Prominent bus stops such as terminals and park-and-ride locations have route map postings and schedule listings; however, many intermediate bus stops between bus transit centers lack these wayfinding features. This creates difficulty for passengers boarding and/or alighting their bus, especially at many of the more uncommon locations along their route. The only bus transit center in the area is located in Ala Moana Shopping Center, which is mostly beneficial to those arriving to and/or departing from the Ala Moana Center. The largest share of bus riders for the entire bus transit network originate in Waikīkī; however, there is neither a prominent transit center, nor terminal with adequate and intuitive posted wayfinding features; simply individual on-street bus stops.<sup>174</sup>

Both traffic delays and passenger delays contribute to longer wait times at bus stops between rides, frequently causing bus routes, specifically Route 8, to be late. A significant finding reported by the Waikīkī Transit study notes that the actual time spent traveling on the bus is considerably longer than the posted travel times. In 2012, Route 8 was found to be late about 37% of the time when traveling during the evening and 46% of the time when traveling from the shopping center into Waikīkī. Other routes between these destinations were also found to have poor arrival schedules. Overall, this significantly increases the total traveling time a passenger must wait to reach their destination, creating an unfavorable transit experience when only traveling three miles.<sup>175</sup>

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<sup>173</sup> Ibid.

<sup>174</sup> Ibid.

<sup>175</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016).

*Higher Demand:*

According to future development projections, there will be considerable demand for public bus transit when traveling between Ala Moana and Waikīkī. For the 2030 *Build-Project* scenario where the rail route terminates at Ala Moana, there is expected to be a heavy volume of people entering and exiting the station daily. It is estimated that 22,610 people that will be entering and exiting the rail station at Ala Moana—more than twice the amount of any other rail station along the project corridor. Whereas current bus transit has passengers boarding and alighting across several bus stops, the rail station focuses a higher number of individuals at specific point.

Destination	Bus Total Passengers	Rider Share	Walk/Bike	Rider Share	Kiss n' Ride	Rider Share	Parking	Rider Share	Total
Ala Moana	17,790	79%	3,680	16%	890	4%	250	1%	22,610

Table 5: Daily Mode of Access to Ala Moana Station

Source: Rail EIS<sup>176</sup>

While increased foot traffic at Ala Moana Center may be economically beneficial to businesses located around the area, the high volume of individuals will heavily increase the demand of bus transit and the number of buses operating on an already heavily congested roadway network. For example, the number of buses projected to operate along route 8 will increase to more than 16 with new route restructuring plans. Though many of the bus routes serving Ala Moana to other island destinations will be rescheduled and rerouted to work more effectively with the rail project, the routes serving passengers between Ala Moana Center and Waikīkī will remain. With roadway congestion expected to worsen, additional buses will contribute to already overloaded roadways.<sup>177</sup>

<sup>176</sup> City and County of Honolulu, *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016), 42.

<sup>177</sup> Waikiki Regional Circulator Study, report, Department of Transportation Services (Honolulu, HI: Weslin Consulting Services, 2013).



### *Private Automobiles*

Automobiles are the most used mode of transportation by local residents on Oahu and between Ala Moana and Waikīkī. Based on the overall projections of automobile trips made for the entire island, private automobile use is expected to increase. Automobiles traveling between these destinations operate on the same roadways as bus routes and bicycle lanes. The most heavily used roads include Kapi‘olani Boulevard, Ala Moana Boulevard, McCully Street, Kalakaua Avenue, Kūhīo Avenue, and Ala Wai Boulevard, for both eastbound and westbound directions.<sup>178</sup>

Traffic data shows that these roadways experience high vehicular volumes, with the highest along Ala Moana Boulevard, Ala Wai Boulevard, and Kapahulu Avenue. While these numbers reflect the total amount of vehicles, a large majority is attributed to individual automobiles. Most trips are made by residents traveling to and from work as well as tourists traveling between amenities. These high volumes coupled with narrow roadways create traffic choke points and automobile queues at several intersections; the worst being at McCully and Kalakaua Avenue, and Ala Moana Boulevard and Kalakaua Avenue - two major access points between these destinations.<sup>179</sup>

Roadway	Volume
Kapi‘olani Boulevard	36,998
Ala Wai Boulevard	51,548
Ala Moana Blvd By Shopping Center	45,693
Kalakaua Ave. at Kapi‘olani Blvd.	35,946

Table 6: Connection 01 - Daily Vehicular Volume

Source: Rail EIS<sup>180</sup>

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<sup>178</sup> "Traffic Counts—Esri Demographics | Arcgis", Doc.Arcgis.Com, 2016, accessed December 12, 2016, <https://doc.arcgis.com/en/esri-demographics/data/traffic-counts.htm>.

<sup>179</sup> Ibid.

<sup>180</sup> City and County of Honolulu, *Honolulu High-Capacity Transit Corridor Project*, Addendum 01 To The Transportation Technical Report (Honolulu: City and County of Honolulu, 2009), Accessed January 4, 2016, 119, [http://www.honolulutraffic.com/Technical\\_reports/addendum\\_02\\_to\\_transportation\\_tr\\_final.pdf](http://www.honolulutraffic.com/Technical_reports/addendum_02_to_transportation_tr_final.pdf).

It is estimated that about 82% of all individual's preferred mode of transportation is by private automobile. However, even after rail is constructed, the percentage of automobile drivers is expected to only be reduced down to 80%. In 2030 after the initial rail route is constructed, the total number of daily trips made by private automobiles is expected to rise 20% to 2,767,600. <sup>181</sup>

One of the major drawbacks for individuals traveling to Waikīkī by automobile is the lack of public parking. Majority of on-street parking in Waikīkī is located along Ala Wai Boulevard and many of the smaller streets running perpendicular to Kalakaua Avenue. These parking stalls, however, are extremely limited and time restricted depending on if they are metered. Off street parking is provided by private hotels and shopping centers at several locations around Waikīkī, including the Royal Hawai'ian Shopping Center and International Market Place; however, hourly parking rates are high and spaces are limited, especially during peak hours. Furthermore, the Waikīkī Special District, which governs the design requirements for all buildings in the Waikīkī area, proposed an amendment which would eliminate off-street parking requirements for small commercial properties in the future. This change is an attempt to alleviate restrictions on design improvements to the Waikīkī area, however, it would prevent parking in the area and direct drivers to park at other major off street parking lots or outside of Waikīkī. <sup>182</sup>

For individuals driving to Ala Moana from Waikīkī, parking around the Shopping Center is limited as well. While the shopping center provides a large quantity of on-street spaces within their garage, on-street parking outside of the mall is difficult to find. In the same Ala Moana stakeholder survey, participants reported that locating on-street parking was challenging. Of the people who participated in the survey, 40% said that parking was poor; 41% said that parking was fair; 17% said parking was good; and only 2% said that parking was excellent. <sup>183</sup>

### *Bicycling:*

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<sup>181</sup> Ibid., 14.

<sup>182</sup> Department of Planning and Permitting, *Revisions To Waikiki Special District - Background Report* (Honolulu: The City and County of Honolulu, 2011).

<sup>183</sup> National Research Center, *Ala Moana Community Survey* (Honolulu: City and County of Honolulu, 2012).



Bicycling is one of the quickest methods for circulating around Honolulu. While several bicycle routes link Ala Moana and Waikīkī, transit between these two destinations by bicycle is one of the least used methods of transportation. When traveling between Ala Moana Shopping Center and Waikīkī, bicyclists primarily use the same roadway network at automobiles and bus transit. Bicyclists moving from Ala Moana to Waikīkī travel along unprotected bicycle lanes along Ala Moana Boulevard and Kalakaua Avenue. When traveling westbound to Ala Moana, bicyclists utilize the unprotected bicycle lane along Ala Wai Boulevard.<sup>184</sup>

The routes between Ala Moana and Waikīkī were found to be especially dangerous. Though bicyclists have their own lane for majority of their trip, the lanes are narrow and unprotected, forcing riders to travel alongside speeding vehicles. For example, Ala Moana Boulevard has a posted speed limit of 35 mile per hour along the shopping center, and Ala Wai Boulevard has a 25 mile per hour speed limit. However, most vehicles traveling along these routes operate faster than the actual speed limit signs suggest—resulting in bicycle related accidents at intersections on these roadways.<sup>185</sup>

While most residents and visitors understand the benefits of bicycling, many still choose to drive, mainly due to the dangerous conditions bicyclists face between these areas. According the same Ala Moana survey, community members reported that bicycling in general – including infrastructure and safety - was poor in comparison to public transit and automobiles.<sup>186</sup>

Though bicycling is currently viewed as dangerous, the number of people using bicycles as a mode of transportation is not expected to increase in the future. According the Oahu Bicycling Plan 2012, bicycling infrastructure is expected to be improved to create an overall safer and more direct connection to the Ala Moana rail station. As rail and bus transit is expected to increase, many people are projected to use bicycles to reach their final destination from transit stations, especially as people are allowed to bring their bicycles on

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<sup>184</sup> Ibid.

<sup>185</sup> SSFM International, *Honolulu Complete Streets Implementation Study Location Report*, Final (Honolulu: City and County of Honolulu, 2015), 6.

<sup>186</sup> National Research Center, *Ala Moana Community Survey* (Honolulu: City and County of Honolulu, 2012), accessed April 1, 2017, [https://www.honolulu.gov/rep/site/dpptod/alamoana\\_docs/AlaMoanaTODSurveyReport-Nov12.pdf](https://www.honolulu.gov/rep/site/dpptod/alamoana_docs/AlaMoanaTODSurveyReport-Nov12.pdf).

the train.<sup>187</sup>

Direction	Commute Time (Peak / Non-Peak)		
	Bus	Automobile	Bicycling
Ala Moana to Waikīkī	24 / 23	24 / 21	12
Waikīkī to Ala Moana	33 / 25	24 / 20	12

Table 7: Current Average Commute Time for Peak and Non-Peak Travel Periods (Minutes)

Source: Google Maps<sup>188</sup>

### Connection 01: Transportation Network Summary

- Buses are vulnerable to traffic delays.
- Buses are slowest when driving through Ala Moana or Waikīkī.
- Frequent instances of passenger delay.
- Needs more intuitive Wayfinding.
- Buses are sometimes late.
- Parking is limited at each destination during peak hours, especially Waikīkī.
- Major congestion along connecting roadways.
- Bicycling infrastructure is unsafe.

<sup>187</sup> Helber Hastert & Fee, Planners, *Oahu Bike Plan* (Honolulu: City & County of Honolulu Department of Transportation Services, 2012).

<sup>188</sup> "Honolulu, HI" Destinations Map. Google Maps. Accessed March 1, 2016. <https://www.google.com/maps/@21.2917045,-157.7914041,15z>

### 6.3 Connection 02: Ala Moana Shopping Center and UH Mānoa

Ala Moana and UH Mānoa draw a high amount of daily trips to their locations. UH Mānoa, as well as adjacent educational institutions and residential neighborhoods, have a high number students, faculty, and residents. Ala Moana Shopping Center, as a world-class shopping center sees a high population of both residents and visitors. However, both destinations have surrounding residential neighborhoods and a high concentration of jobs, which creates a large volume of people traveling between them.

Ala Moana's significance will only increase in the future as the terminus for the future rail guideway is projected to greatly intensify daily transportation trips taken between the destinations. Of the 30,000 affiliates that travel to the University daily, nearly 1/3 of them travel from West O'ahu, meaning a high number of transportation trips for work and school purposes will be made along arterial roadways including Kapi'olani Boulevard, University Avenue, Keamoku Street, and King Street.

#### *Bus Patterns:*

Public bus transit is one of the most heavily used modes of transportation used by off-campus UH Mānoa affiliates. It is estimated that nearly 85% of all UH affiliates live within a quarter mile of a bus stop. Of these affiliates, 21% of them used public transit to reach UH Mānoa daily. The most frequented bus routes used by passengers between Ala Moana and UH Mānoa are bus routes 6, 13, 18, and A. Each heavily use University Avenue, arriving at one of the three major bus stations on campus. The primary bus stops are located at Sinclair Circle with 2,335 daily boardings; University and Metcalf with 1,913 daily boardings; and University and Dole with 896 daily boardings.<sup>189</sup>

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<sup>189</sup> Campus Transportation Demand Management Plan, report, University of Hawaii, April 27, 2016, 15-26, accessed October 27, 2016, <http://manoa.hawaii.edu/planning/TDM2012.pdf>.

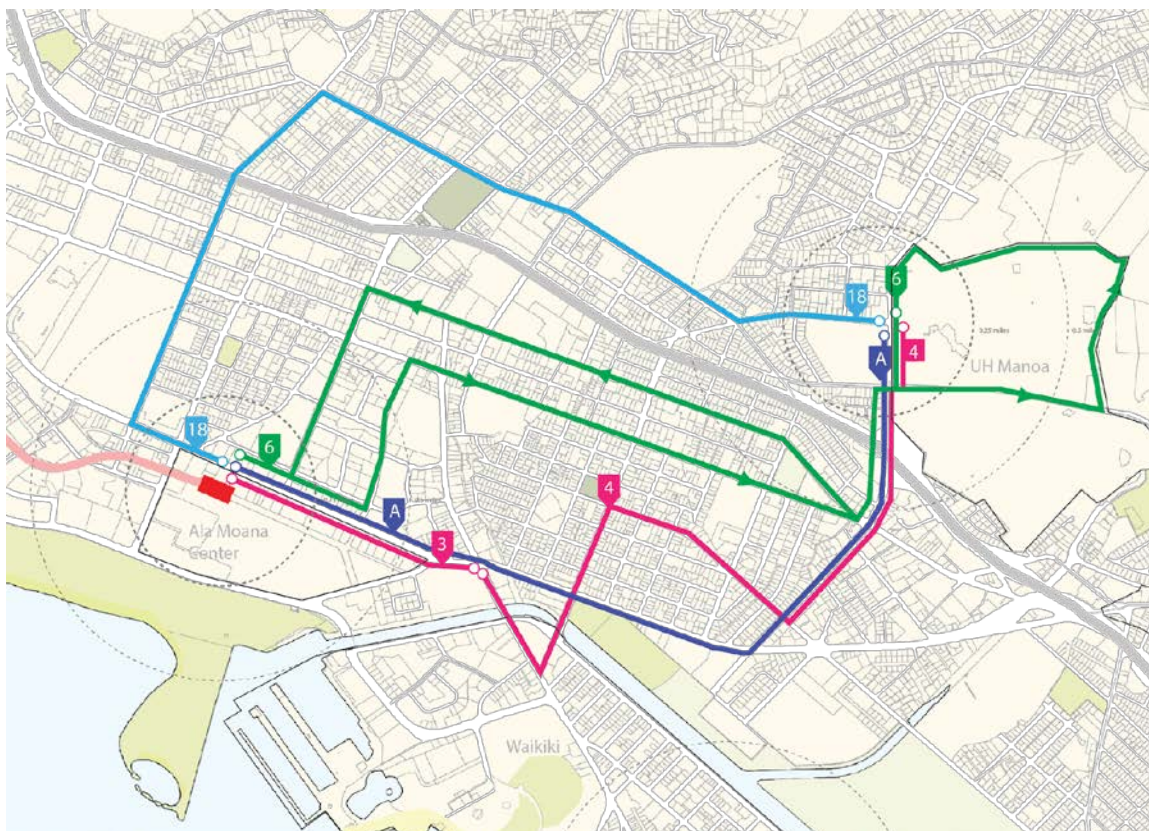


Figure 22: Fastest and Most Direct bus routes between UH Mānoa and Ala Moana Center – Routes A, 18, 6, 4, and 3

Source: Made By Author

One issue is the unmet demand for public transportation. According to a transportation survey conducted by the University of Hawai‘i, 21% of people who currently do not ride the bus are expected to utilize transit in the future, potentially creating another 3,737 public transit users.<sup>190</sup>

One of the major issues of bus transit service leaving UH Mānoa is the lack of convenience, the inflexibility of routes, and the low capacity of buses, especially during peak hours. According to a transportation survey conducted by the University of Hawai‘i, 60% of respondents said they were able to make their desired trip due to the crowded bus

<sup>190</sup> Existing Conditions Report: Campus Transportation Demand Management Plan, report, University of Hawaii, November 2011, 7-12, accessed October 27, 2016, [https://manoa.hawaii.edu/commuter/resources/PDFs/UHMEExistingConditionsReport\\_November2011.pdf](https://manoa.hawaii.edu/commuter/resources/PDFs/UHMEExistingConditionsReport_November2011.pdf)

conditions during peak hours and the inflexibility of bus routes.<sup>191</sup>

To create better transit access between UH Mānoa and Ala Moana Rail Station, bus routes will be restructured to connect more directly to the rail system and accommodate the increased transit demand between the destinations. While this would provide greater and more direct access, buses will still need to operate on the existing roadway network, where congestion is expected to increase.<sup>192</sup>

#### *Automobiles:*

The most used mode of transportation when traveling to UH Mānoa is by private automobile. Of the 30,000 affiliates that travel to the University daily, nearly 1/3 of them travel from West Oʻahu, and nearly 43% of them drive alone. The high numbers traveling from West Oʻahu reflect the growing issues of congestion around UH Mānoa.<sup>193</sup>

Deteriorating roadway conditions between Ala Moana and UH Mānoa, primarily due to congestion is one of the biggest issues for all roadway vehicles. Main arterial roadways such as Kapiʻolani Boulevard, University Avenue, Keamoku Street, and King Street suffer heavy traffic.

University Avenue is the gateway arterial roadway that provides access to UH Mānoa. However, due to the high volume of automobiles accessing UH Mānoa, intersections at King Street, Dole Street, and Metcalf Street along University Avenue create choke points. Because a majority of private automobiles are driven by residents going to school or work, the University is currently planning to reduce the parking to promote alternative modes of transportation.<sup>194</sup>

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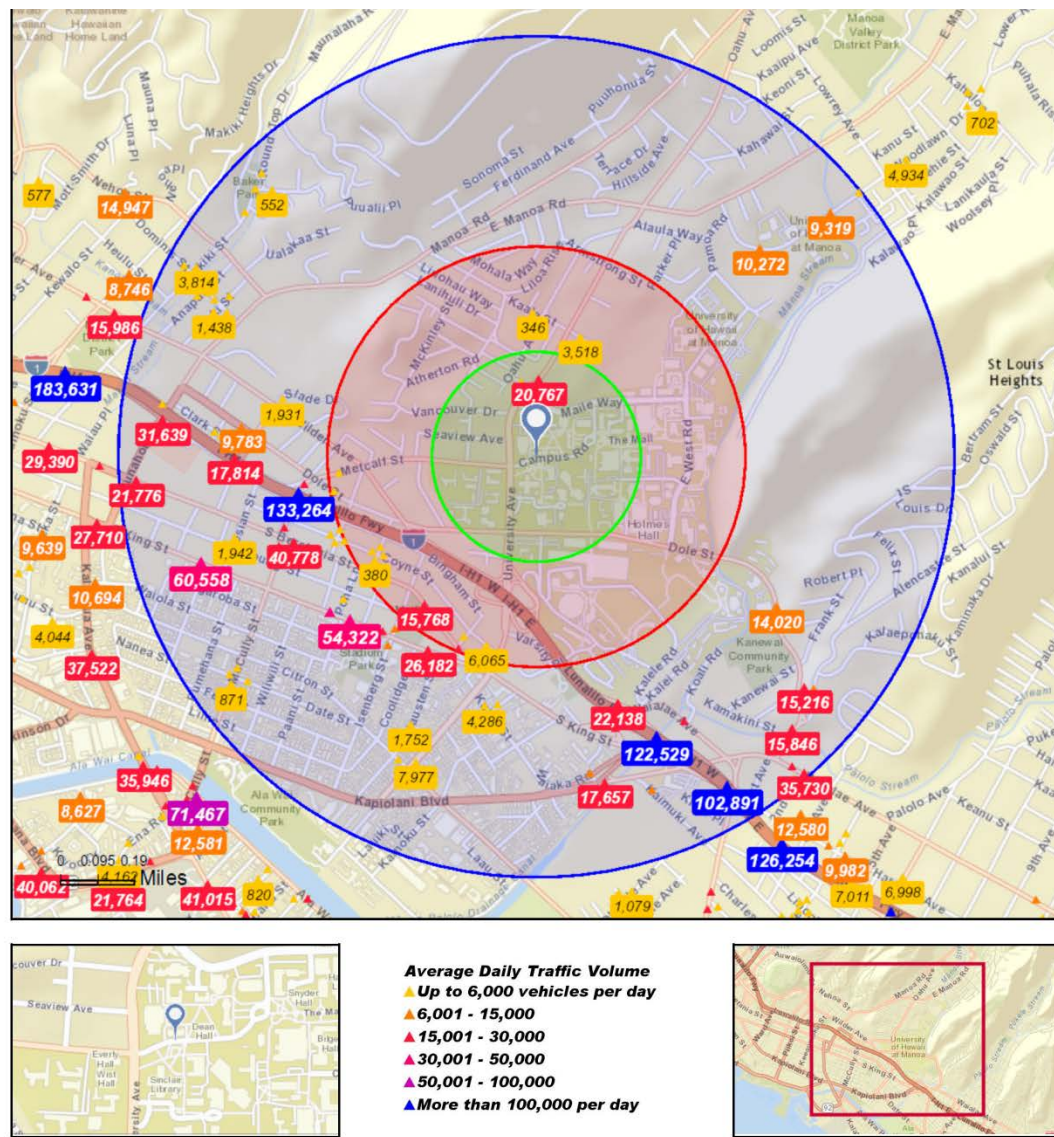
<sup>191</sup> Ibid.

<sup>192</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, 3-25.

<sup>193</sup> *Campus Transportation Demand Management Plan*, report, University of Hawaii, 24-25.

<sup>194</sup> Ibid.





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Figure 23: Traffic Volumes near UH Mānoa

Source: ESRI<sup>195</sup>

While there is sufficient parking on and off campus, the high number of affiliates driving to UH Mānoa over recent years has made parking increasingly competitive. In 2012, The University of Hawai‘i Existing Conditions Report estimated that there were approximately 5,497 parking stalls on campus, and 1,240 on-street parking spots near

<sup>195</sup> Ibid.

campus.<sup>196</sup>

In an effort to transition affiliates to be more transit oriented, the University plans to eliminate much of the on-campus parking, especially on the upper campus side of the university. Currently faculty and staff are the primary users of on-campus parking, and as an incentive to use transit, especially with the new rail project, the University plans to provide free public transit passes as an alternative to driving and parking. Within the next four to six years, it is estimated that up to 270 on-campus parking stalls will be removed.<sup>197</sup>

### *Bicycling:*

According to a UH Mānoa transportation study, there is a large market for bicycling to and/or on campus; still, most choose to travel by transit or automobile. A total of 43% of a UH Mānoa affiliates live within the bicycle catchment zone—within a three mile radius from UH Mānoa. However, bicycling between these destinations was found to be dangerous and perceived as unsafe because the majority of current bicycle routes travel along arterial roadways carrying high volumes of fast-moving vehicles.<sup>198</sup>

While King Street has a protected bicycling lane, University Avenue's bicycling infrastructure is narrow and unprotected. Although University does have a bicycling lane, it ends around the H1 Freeway overpass and then transitions into a bicycle route that shares the same lane as automobiles. Unfortunately, the transition occurs near a series of freeway on-ramps and off-ramps, creating an increasingly hazardous area for both bicyclists and pedestrians.<sup>199</sup>

Another reason as to why bicycling is perceived as dangerous, is because the built design speed along University Avenue is much higher than the posted speed. While there is speed limit signage and painted roadway cues, automobiles continually travel much faster than the posted 25 miles per hour. While this roadway is a primary transportation artery, moving approximately 34,174 vehicles per day, the high speeds pose a danger to

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<sup>196</sup> Existing Conditions Report: Campus Transportation Demand Management Plan, report, University of Hawaii, November 2011, 7-12, accessed October 27, 2016, \_.

<sup>197</sup> Ibid.

<sup>198</sup> Ibid.

<sup>199</sup> Campus Transportation Demand Management Plan, report, University of Hawaii, 11-15.

those bicyclists and pedestrians attempting to share the roadway.<sup>200</sup>

*Mode Commute Times:*

Overall commute times between UH Mānoa and Ala Moana Center are somewhat long when considering these destinations are only three miles apart. When comparing transportation modes, bus transit commutes are the longest compared to driving alone or bicycling, as shown in table below. Although bus times are shown to be only a few minutes longer than private automobile times, these times do not account for time spent waiting for a bus to arrive, late arrivals, passenger loading times, etc. And thus, transit commute times could be considerably longer than the table suggests. The average commute time for bus transit from Ala Moana to UH Mānoa is approximately 23-25 minutes during peak rush hour, and 22 minutes during non-peak rush hour periods. For automobiles, the average commute time during peak rush hour is 20 minutes, and 18 minutes during non-rush hour periods. Even today, bicycling remains the fastest mode of transportation.<sup>201</sup>

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<sup>200</sup> SSFM, 12

<sup>201</sup> "Honolulu, HI" Google Maps, accessed March 30, 2017, <https://www.google.com/maps/@21.2917045,-157.7914041,15z>.



Direction	Commute Time (Peak / Non-Peak)		
	Bus	Automobile	Bicycling
Ala Moana to UH Mānoa	25 / 22	20 / 18	15
UH Mānoa to Ala Moana	23 / 22	20 / 18	15

Table 8: Connection 02 - Commute Time for Peak and Non Peak Travel Periods (Minutes)

Source: Google Maps<sup>202</sup>

#### Connection 02: Transportation Network Summary

- Buses are vulnerable to traffic delays
- Buses are sometimes over capacity
- Parking is limited at each destination during peak hours, especially at UH Mānoa
- Congestion along University Avenue, Kapi‘olani Boulevard during peak hours
- Roadways are designed for speeds higher than posted speed limits
- Vehicles given priority over bicyclists and pedestrians
- Bicycling infrastructure is perceived as unsafe

<sup>202</sup> “Honolulu, HI” Google Maps. Accessed March 1, 2016. <https://www.google.com/maps/@21.2917045,-157.7914041,15z>

## 6.4 Connection 03: Waikīkī and UH Mānoa

While located only about three miles apart, the geography and roadway network between UH Mānoa and Waikīkī still do not allow for any direct pathways of access—disconnecting two of the most important destinations for the island of O‘ahu. Each destination draws a high volume of people daily from areas all over the island by different modes of transportation. UH Mānoa sees a demographic comprised of mainly students and residents. And in contrast, Waikīkī’s role as a major economic center has a mixed demographic with a high number of residents and visitors.

However, the number of people traveling between UH Mānoa and Waikīkī on a daily basis draw lower amounts of daily trips, primarily because these areas do not pull as many West O‘ahu residents traveling between work and home destinations. With that being said, there still remains a considerable amount of transportation use between the two areas; as students, faculty, and staff occupy some of the 22,750 individual housing units that exist in Waikīkī.<sup>203</sup> The University’s Campus transportation plan found that nearly 3% of all UH affiliates live in Waikīkī and travel primarily by private automobile and bus transit to UH Mānoa every day.<sup>204</sup>

The Ala Wai Canal, a wide artificial waterway that surrounds Waikīkī, creates a landscape barrier blocking all modes of transportation traveling from Mānoa. With no central roadway or pedestrian bridge providing access across the Ala Wai, ingress and egress traffic for bus transit, automobiles, bicyclists, and pedestrians are forced towards the Ewa and Diamond Head end of Waikīkī. The main roadways that are traveled between these destinations, by all modes of transportation, include Kapahulu Avenue, University Avenue, Ala Wai Boulevard, Kapi‘olani Boulevard, and Kalakaua Avenue.<sup>205</sup>

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<sup>203</sup> "Waikiki Neighborhood in Honolulu, Hawaii (HI), 96814, 96815 Subdivision", *City-Data.Com*, 2016, <http://www.city-data.com/neighborhood/Waikiki-Honolulu-HI.html>.

<sup>204</sup> Campus Transportation Demand Management Plan, report, University of Hawaii, \_.

<sup>205</sup> : Department of Transportation Services, *Ala Wai Pedestrian Safety And Mobility Project : Application*(Honolulu: Honolulu City and County, 2016).

*Bus Transit:*

Because there is a smaller market of people traveling directly between Waikīkī and UH Mānoa, bus routes and frequency between the two destinations are more limited. Route 13 is currently the only route to provide direct bus transit between these destinations without requiring passengers to walk and/or transfer to another bus. When traveling from UH Mānoa, passengers board this route from a bus stops along University Avenue or Dole Street, which then travels along University Avenue, Kapahulu Avenue, and Kūhīo Avenue in Waikīkī—roadways used by all other transit modes.<sup>206</sup>

However, the number of transit trips are expected to greatly increase with improved public transit access provided by the new rail project. According to the Rail EIS, in 2030, demand for trips between Waikīkī and UH Mānoa—by bus transit only—is expected to rise to nearly 1,000 trips, even under the no rail project alternative. Under the rail project with proposed extensions leading to UH and Waikīkī, that demand is expected to double, even though rail and the restructured bus transit system still does not provide direct access between UH Mānoa and Waikīkī across the Ala Wai Canal.

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<sup>206</sup> Ibid.



Figure 24: Fastest and Most Direct bus routes between UH Mānoa and Waikīkī – Routes 13, 4, and 2L

Source: Made By Author

#### *Automobiles:*

For residents traveling between UH Mānoa and Waikīkī, transportation by automobile is comprised of more than half of all transit mode choices. Based on the overall ridership choice of UH affiliates traveling to school and work, the majority of total mode trips taken between these destinations are made by private automobile.<sup>207</sup> This presumption is further supported by the high volume and congestion of automobiles that connect Waikīkī and UH Mānoa.

Kapahulu Avenue acts as a minor arterial roadway with 33,900 vehicles traveling

<sup>207</sup>Ibid.

along only four lanes daily, providing access to H1 for the surround neighborhoods in Waikīkī and Kaimukī. Because existing parking at either location is now limited as efforts are currently underway to reduce the number of existing and future parking spots, the percentage of people using private automobiles compared to other modes of transportation may not be as high as people may opt to use public transit or bicycle.<sup>208</sup>

### *Bicycling:*

Nearly all of the existing bicycle routes and lanes that link these destinations operate on the same road network that vehicles use. When traveling from UH Mānoa to Waikīkī, bicyclists most frequently use University Avenue, Kapi‘olani Boulevard, and/or Kalakaua Avenue. When traveling in the opposite direction from Waikīkī to UH Mānoa, bicyclists use Ala Wai Boulevard, Kapi‘olani Boulevard, and University Avenue. These pathways use a combination of bicycle routes and lanes along these roadways; however, there is a lack of protection from vehicles that frequently travel above the 25 mile per hour speed limit.

Though these are the quickest and most direct paths between UH Mānoa and Waikīkī, bicyclists are still forced to use the McCully Bridge to traverse the Ala Wai Canal, increasing the total length of their journey by approximately one mile. Though this is a relatively short bicycle ride, the lack of bridge access increases the overall bicycling distance by 33%, adding 4-8 extra minutes to the total commute time. The indirectness of these close destinations further erodes transportation efficiency and access, potentially deterring people from choosing bicycling over driving.<sup>209</sup>

While data and projections exist on current transit ridership between UH Mānoa and Waikīkī, there is currently no data on the exact quantity of bicycle trips between these destinations. However, as only 10% of all UH affiliates use bicycles to travel between their destinations, it can be presumed that residents, students, and visitors bicycling consists of the smallest percentage of the total transportation modes used.<sup>210</sup>

There is, however, a potentially large market for bicycle users in the future. Because

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<sup>208</sup> "Traffic Counts—Esri Demographics | Arcgis", Doc.Arcgis.Com, 2016, <https://doc.arcgis.com/en/esri-demographics/data/traffic-counts.htm>.

<sup>209</sup> Ibid.

<sup>210</sup> Ibid.

UH Mānoa and Waikīkī are located within three miles of each other, they are within the bicycling catchment zone—the furthest reasonable distance that people are willing to travel by bicycle to. According to the University’s transportation survey, 77% of people who do not bicycle to UH Mānoa would consider bicycling if improvements were made to promote a safe bicycling journey.<sup>211</sup>

*Mode Commute Times:*

Between UH Mānoa and Waikīkī, it was found that commute times between these destinations were considerably long due to the Ala Wai Canal boundary and traffic heavy congestion along University and Kapahulu Avenues. The average commute time for bus transit from UH Mānoa to Waikīkī is approximately 28 minutes during peak rush hour, and 22 during non-peak rush hour periods. For automobiles, the average time for driving during rush hour is 28-24 minutes, and 20-24 minutes during non-rush hour periods. Bicycling still remains the fastest mode of transportation.

Direction	Commute Time (Peak / Non-Peak)		
	Bus	Automobile	Bicycling
Waikīkī to UH Mānoa	28 / 22	24 / 20	18
UH Mānoa to Waikīkī	28 / 24	28 / 24	18

Table 9: Connection 03: Commute Time for Peak and Non Peak Travel Periods (Minutes)

Source: TheBus.org, Google Maps, Walkscore.com

<sup>211</sup> Campus Transportation Demand Management Plan, report, University of Hawaii, 18.

### Connection 03: Transportation Network Summary

- Indirect connections between destinations
- Buses are vulnerable to traffic delays
- Buses are slow along these routes
- High bus passenger delay
- Needs more intuitive Wayfinding
- Parking is limited at both destinations during peak hours
- Congestion along Kapahulu Ave., Kapi‘olani Blvd., Ala Moana Blvd., University Ave. during peak hours
- Bicycling infrastructure is unprotected along roadways

## 6.5 Connection 04: Kaimukī – Waialae

### *Overview*

While the neighborhood of Kaimukī covers approximately 1.91 square miles, the primary area being studied is Waialae Avenue, which is considered to be *main street* of Kaimukī—its town center. Waialae Avenue is a 1.2 mile, 4 to 6 lane arterial roadway lined with numerous small businesses, and is the only major street that parallels the H1 Freeway. This street services a high volume of daily traffic by residents from neighborhoods including Makiki, Mānoa, Kaimukī, and Waialae-Kahala—all of which are located near major transportation modes. It is also the primary access road to the valley and ridge communities of St. Louis Heights, Palolo, and Wilhelmina Rise.<sup>212</sup>

### *Bus*

The commercial areas along Waialae Avenue are heavily served by bus transit. There are approximately 12 bus stop locations that are strategically placed at areas of higher demand. These locations include the intersections around the Kaimukī town center; between 9<sup>th</sup> Avenue and Koko Head Avenue; the educational institutions near the Palolo and Waialae Avenue intersections; and the access roadway to UH Mānoa at the intersection of St. Louis Drive and Waialae Avenue. These stops serve five major bus routes including Routes 1, 9, 9S, 14, and 1L. It is estimated that 7% of all daily public transit trips originate from the Kaimukī neighborhood, with majority expected to travel to the major employment areas of Downtown–Ala Moana, Waikīkī, and UH Mānoa. The busiest bus stop locations were found to be located at either ends of Waialae Avenue, at the intersections of Waialae and St. Louis Drive, as well as at the intersection of Waialae and Koko Head Avenue.<sup>213</sup>

One of the drawbacks of using bus transit along Waialae Avenue is that it frequently blocks traffic when picking up and dropping off passengers at the many bus stop locations. Since the width of Waialae Avenue varies between 4 and 6 lanes of traffic, frequent stops commonly slows the flow of traffic, further worsening congestion primarily during peak

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<sup>212</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016)., 3-56.

<sup>213</sup> *Ibid.*



travel periods and increasing total commute times.



Figure 25: Fastest and Most Direct bus routes between Kaimukī, UH Mānoa, Waikīkī, and Ala Moana – Bus Routes 9; 13; 1; 1L; 6->1; 9->23; 1L->13

Source: Made By Author

### *Automobile*

As with the rest of Honolulu, automobiles are the most preferred mode of transportation along Waialae Avenue. In the entire neighborhood of Kaimukī, it is estimated that 60% of residents choose to drive, with less than 10% choosing bus transit and bicycling combined. As an arterial roadway, Waialae Avenue sees a volume of approximately 35,730 per day, nearly the same as Kapahulu and University Avenues.<sup>214</sup>

Traffic congestion along this street is heavy considering the surrounding neighborhoods feed into Waialae Avenue. During peak morning and evening hours, traffic

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<sup>214</sup> Ibid.

is focused around the schools between 8<sup>th</sup> Avenue and 3<sup>rd</sup> Avenue, as well as the intersection at St. Louis Drive and Kapi‘olani Boulevard. This is due to both residents traveling to employment destinations in the Ewa direction, as well as students traveling to the numerous educational facilities along Waialae Avenue and in Mānoa.

### *Bicycling*

While Waialae Avenue has dedicated cycling lanes, travelling both westbound and eastbound, these pathways are unprotected and share the same roadway network as buses and automobiles. A 3-day study conducted by the Honolulu Bicycling League counted an average of 324 bicycles traveling down Waialae Avenue during the morning and evening rush-hour observation period. Even though it was found that Waialae Avenue sees a relatively high volume of bicyclists compared to Honolulu’s other bicycling lanes, 30% of bicyclists were recorded to have been using the sidewalks instead of the dedicated bicycle lanes. A percentage this large may suggest that many cyclists feel unsafe sharing the roadway with other vehicles without quality bicycling infrastructure, which would need to consist of wider lanes and better protection from vehicles.<sup>215</sup>

Direction	Commute Time (Peak / Non-Peak)		
	Bus	Automobile	Bicycling
Kaimukī to UH Mānoa	25 / 20	22 / 12	12
Kaimukī to Waikīkī	41 / 35	40 / 30	15
Kaimukī to Ala Moana Shopping Center	40 / 23	32 / 23	19

Table 10: Commute Time for Peak and Non-Peak Travel Periods (minutes)

Source: TheBus.org, Google Maps, Walkscore.com

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<sup>215</sup>Ibid.

- Buses are vulnerable to traffic delays.
- Frequent Bus Stops along Waialae Avenue increase congestion during peak hours
- Vulnerable to congestion near the numerous educational institutions
- Relatively large bicycling volume

## 6.6 Findings

*Finding: There is a large potential market for public transit*

Though there currently exists a large demand for public transit use between these destinations, these transportation studies have shown that this market will increase with a greater network of public transit focused on access, reliability, and efficiency. In 2030, the projected amount of daily riders expected to use rail is 116,300. With the planned rail extensions in West O‘ahu, Pearl City, and East Honolulu, the projected number of riders is expected to increase 28% to 148,300 due to greater access to high density neighborhoods, educational institutions, and major economic center. Community surveys have shown that people view public transit positively; however, issues of capacity and directness deter them from doing so. <sup>216</sup>

Alternative Project	Rail Boardings
Rail Project	116,300
Rail Project w/ Extensions	148,300
% Ridership Increase	28%

Table 11: Public Transit Ridership Increase Projections – 2030

Source: *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016)

<sup>216</sup> *Honolulu High-Capacity Transit Corridor Project Final Environmental Impact Statement*, Chapter 3 (Honolulu: The City and County of Honolulu, 2016), 3-56.

*Finding: Bus transit commute times will likely remain slow*

With the rail project constructed, there will be some restructuring of the existing bus transit system. Buses for both destinations will be rerouted to more effectively feed into the Ala Moana Rail Station, and schedules and arrival frequency will be accommodating to rail's boarding and arrival times. While this will help to mitigate congestion and slow commute times, many of the buses will still operate along the same arterial roadways such as Kapi'olani Boulevard, University Avenue, and Kapahulu Avenue—each thoroughfares that are currently exceeding over capacity.

*Finding: Waikīkī is Disconnected*

While congested roadways remain the primary cause of connectivity between these destinations, the Ala Wai Canal disconnects Waikīkī from the surrounding neighborhoods as well as UH Mānoa. There are currently access bridges across the Ala Wai Canal on the Ewa and Diamond Head ends of Waikīkī; however, there is no intermediate vehicular or pedestrian bridge between them. People commuting down University Avenue and traveling into Waikīkī need to access the area by using the access points on either end, further extending the overall commute time and distance. As University Avenue provides a roadway for adjacent neighborhoods and education institutions, a large volume of vehicles are consequently directed toward busy intersections, or choke points, only further intensifying congestion.

*Finding: Bicycle infrastructure is perceived as unsafe*

As Waikīkī, Ala Moana, and UH Mānoa are located within the 3-mile bicycle catchment zone, there is a potentially large market of people willing to use bicycles to travel between their destinations. Several surveys have found that nearby residents who drive alone would be willing to use bicycling as their preferred mode of daily transportation. Unfortunately, most defer using bicycles due to the perception that infrastructure is unsafe. Aside from the King Street bicycle lane, all bicycle routes and lanes between these destinations are unprotected, requiring bicyclists to ride alongside vehicles traveling above 25 miles per hour.

One of the most important methods for increasing bicycle and pedestrian use is to

provide a well-connected multi-modal transportation network. If bicycling infrastructure doesn't provide basic needs such as safety and directness, people may continue to use their automobiles, only maintaining the city's unbalanced transportation system.

*Finding: Parking is Limited*

Projections indicate a high increase in automobile traffic across the island. While there will also be a large transition of people using alternative forms of transportation, finding available parking spaces will be much more competitive. With development and policy underway to reduce and limit future parking availability, people traveling by private automobile will most likely spend even more time and money for parking.

*Finding: There is Opportunity for Stronger Transit Mode Links*

A key aspect to creating stronger connections within the urban environment is having greater access to multiple modes of transportation. The new rail station at Ala Moana Center will increase the number of individuals utilizing public transit; however, certain areas will need a more seamless transition between transportation choices. Waikīkī, for instance, lacks a central transportation terminal that effectively transitions people between mode networks such as clearly marked bus routes and safe bicycle infrastructure. As Waikīkī has the greatest share of public transit trips as well as a large pedestrian-oriented community, network terminals and/or hubs could provide central bicycle facilities and better wayfinding within a central and prominent station.

## 7.0 Route Assessment

Implementing new transportation infrastructure within a heavily developed urban area is a critical decision as it economically and socially impacts the community's future. While aerial transit may provide many benefits over other transportation systems such as bus and/or heavy rail, aerial transit must fit into the community's overall plan in order to fully benefit the community and work effectively with new development and the existing transportation infrastructure. The proposed aerial transportation network offers Honolulu a unique method of strengthening its urban core. Based on the review of literature, the success of this system relies on the ability for aerial transportation to address three major issues: *supporting the transportation hierarchy, improving access between destinations, and reducing reliance on roadway vehicles*. While these routes vary to certain degrees, each connection supports the underlying themes for a stronger urban core. This chapter describes the benefits and drawbacks of the ART alternatives that are proposed for Honolulu based on the existing and projected transportation patterns described in the previous chapter.

### 7.1 Impacts of Aerial Ropeway Transit on Honolulu

#### *Reduced Vehicle Use*

The overall reduced reliance on vehicles will help to mitigate some of the traffic projected to further intensify between these destinations. 2030 projections indicate that automobile congestion is still expected to rise along with the overall population increase. Though a good amount of people will inevitably still choose the luxuries of their private automobile over any other mode of transportation, aerial transit does provide an alternative that would help to lessen congestion, especially for commuters traveling to and from work. Based on previous assessments, there is a potential for a significant amount of bus riders to shift to aerial transit, thereby reducing the load on the periodically overcrowded bus system. ART would help to ease overcrowding and bus delays during peak A.M. and P.M. hours, thus also possessing the potential to reduce the overall number of buses needed to

operate during these times. Though it is difficult to quantify exactly how much aerial transit will reduce vehicle use, there are several factors aerial transit provides that would most likely influence people to choose one transportation mode over another; these include safety, comfort, time, reliability, convenience, cost, and parking availability.<sup>217</sup>

### *Parking*

The time spent parking is often overlooked as part of the total commute time for traveling by car, and can in fact make up a large portion of the trip if finding an available space is challenging, which is often the case in Honolulu's heavily circulated areas. However, parking will no longer be an issue for aerial transit users. While aerial transit is not likely to improve on- and off-street parking conditions for drivers, individuals who previously drove will no longer need to search and/or pay for parking. As UH Mānoa and Waikīkī have already begun to limit the amount of parking available in each area, aerial transit would allow people to forego this final segment of automobile transit.

### *Safety*

As mentioned in the previous chapters, aerial transit provides an exceptionally safe mode of transportation, especially when considering the ever-present dangers that go hand-in-hand with traveling by automobile along roadways, as independently and fast moving vehicles that converge with both bicyclists and pedestrians. The benefit of aerial transit is its simplicity. The proposed system operates as a single service, making the possibility for collision near impossible. The most dangerous intersections, both identified in the transit site analysis, are along University Avenue and Kapi'olani Boulevard. The proposed aerial transit system traverses over the entire length of these roadways, keeping pedestrians safe while still allowing roadway access points at these major attraction centers/intersections.

### *Commute Time*

Of all factors to be considered, time is the one factor that majority of individuals expressed as being most valuable to them, as most people would prefer to travel between work, home, and play destinations as quickly as possible. Based on aerial transit's ability

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<sup>217</sup> Bryce Tupper. Proposed Burnaby Mountain Gondola Transit Project, 40.

to reduce commute times, a significant amount of automobile users could potentially transition to ART, which would not only free up more leisure time by lessening their daily commute time, but would also help to reduce overall automobile use. Though commute times vary slightly for each route alternative, ART provides the most efficient mode of transit: people would no longer need to enter heavy traffic congestion, they wouldn't need to look for and/or pay for parking, they wouldn't need to adhere to bus schedules and/or wait for late buses, and their overall daily commute times would be greatly reduced.

### *Comfort*

Though passenger comfort was not a major issue for Honolulu passengers, the aerial transit system does provide a more spacious and smooth ride. In Waikīkī especially, aerial transit would not need to stop at the numerous traffic signals and crosswalks at each intersection. Instead, ART passengers will ride smoothly/efficiently/fluentlly between aerial stations, stabilized by the additional overhead support cables unique to the 3S gondola system. And, because ART travels at a higher elevation, passengers can enjoy the view of Honolulu's surrounding environment.

### *Access*

Of all the advantages that aerial transit provides, accessibility is the most important. Direct and efficient access between employment centers, recreation and entertainment locations, and residential areas are vital if the community is to reach its full social and economic potential. One of the main issues, also identified in the previous chapter, is the lack of access between many of these areas. Access across the Ala Wai Canal, for instance, is neither constructive nor efficient. Getting in and/or out of Waikīkī is only possible from either the Ewa or Diamond Head side of the neighborhood, thus forcing people to travel along the entire length of the canal to reach destinations located on the opposite side, which ultimately extends both the commute time and the distance traveled. The proposed aerial ropeway system would provide access across the center of the Ala Wai Canal to improve access and connectivity between Honolulu's nearby destinations.

Wide arterial roadways, particularly those with faster moving vehicles, are also found to be an urban barrier, as they reduce access for both bicyclists and pedestrians. For



instance, there are many underutilized amenities currently located along both University Avenue and Waialae Avenue, however walking distances can be quite far, and sides walks as well as bicycle lanes are perceived by most as unsafe. Thus, aerial transit would create a direct link between many of the most frequented points along these popular routes, providing quick, reliable, and more frequent access for those passengers traveling to and from the various locations.

One viable method for improving access between urban locations is to enhance spatial orientation, or wayfinding, for people unfamiliar with the area. Hawai‘i is projected to see approximately nine million visitors in 2019, only further indicating that both the Ala Moana and Waikīkī areas will have a much greater number of people navigating through them, primarily via public transportation. Improving wayfinding around Honolulu would give visitors a better sense of the city.<sup>218</sup> Due to the specific nature of ART, its travel routes are required to be arranged in a much more direct path between stations. And, while the system’s forthright pathway may seem limiting in some respects, it will in fact provide a much stronger sense of directionality by strengthening wayfinding for individuals navigating the city at ground level.

Another issue, also identified in the previous chapter, is that buses travel along the same roadway network as other vehicles, having no visible or defining route characteristics. This is the root cause for why so many of Honolulu’s visitors rely on the actual bus driver to guide them and give proper directions in regard to where they are trying to go, which ultimately causes many of the buses to fall behind schedule. Thus, the proposed aerial routes would not only allow for clear-cut pathway visibility, but they would also present visitors with a comprehensible and readily accessible mode of transportation able to lead all passengers directly to their desired destination in a most effective and efficient manner.<sup>219</sup>

### *Supporting the Hierarchy*

A well-connected city is not measured simply based on the efficiency of one

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<sup>218</sup> : Department of Business and Economic Development, and Tourism, *Visitor Arrival Forecasts* (Honolulu: State of Hawaii, 2016), [http://files.hawaii.gov/dbedt/visitor/tourismforecast/Forecast\\_Arrivals.pdf](http://files.hawaii.gov/dbedt/visitor/tourismforecast/Forecast_Arrivals.pdf), 1.

<sup>219</sup> Waikiki Regional Circulator Study, report, Department of Transportation Services, 57.

specific mode of transportation, but by how its entire multi-modal system works together to productively transport all passengers to their respective destinations. The transportation hierarchy prioritizes environmentally benign and low-cost modes of transportation over all other modes. The gondola routes proposed for Honolulu fall within the public transit realm—below bicycling and walking; however, the hierarchy does not distinguish between different modes of transportation. Aerial ropeway transit has a considerable number of distinct advantages when compared to the more common modes of public transportation, specifically in regard to the transportation hierarchy’s proposed economic, social, and environmental goals. Unlike the bus transit system, aerial transit is efficient, on-schedule, and has considerably less air pollution emissions. And compared to rail, aerial transit is cost effective, less physically obtrusive, and timelier.<sup>220</sup>

The proposed aerial transit will strengthen the transportation hierarchy by actively supporting travel via bicycling and walking. While the system does not directly improve the negative perception concerning the safety of bicycling in Honolulu, the transit stations will provide facilities that strengthen connectivity and promote its use as a more preferable and sustainable transportation choice. Just as the bus system and rail act as an extension to bicycling, the convenience, frequency, and directness of the aerial transit system will make bicycling around Honolulu much easier and much more enjoyable.

Each of the suspended cabins will be potentially large enough for passengers to bring up to six bicycles, aiding passengers in traveling the *last mile* between the station and their final destination by bicycle. Whereas a full-capacity bus can only carry two bicycles simultaneously, the increased bicycle capacity in each gondola will allow for a better multi-modal experience. As more bicyclists are projected to be using public transit, short-term and long-term bicycle storage that is secure and safe will be provided at each aerial station. The aerial stations will also ensure that the transition between aerial transit and bicycling flows as smoothly as possible. Each station is also located along roadways with dedicated bicycle lanes, allowing the transition from the aerial route to the bicycle route to be immediate. Improved bicycle lanes, proposed by the Oahu Bicycle Plan, will also further strengthen this transition.<sup>221</sup>

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<sup>220</sup> Bryce Tupper. Proposed Burnaby Mountain Gondola Transit Project, 30.

<sup>221</sup> Ibid., 30.

## 7.2 Route Alignment 01

### *Ala Moana Segment*

The rail route terminus is located on the intersection where Kona Street and Kona Iki Street meet—on the mauka side of Ala Moana Shopping Center. Furthermore, the end of this particular rail route would also be the ideal location for the aerial ropeway alignment to begin. Therefore, ART’s first station terminal would be located at Ala Moana Center. The station terminal will need to be constructed adjacent to the rail terminal, on the large parking lot next to Reynolds Recycling and AutoXchange. Ideally, the aerial station would be constructed in conjunction with the rail terminal, allowing passengers traveling beyond Ala Moana Station to continue their trip without having to re-enter another station.

From this location, the aerial route would continue above the tree-line—running above and parallel to the center of Kapi‘olani Avenue—for 0.6 miles toward The Hawai‘i Convention Center. The Hawai‘i Convention Center is an economically and culturally significant landmark destination for the state, providing a 1.1 million square foot space along the Ala Wai Canal that also serves as a gateway landmark to Waikīkī. The center hosts a number of international, domestic, and local events in its 200,000 square foot exhibition hall and many ballrooms, attracting thousands of people per day during such events. Visiting attendants commonly arrive from Waikīkī or directly from the airport. The surrounding area also has a moderate number of nearby residences, and two residential high-rises that lie just adjacent to the proposed aerial station stop: Century Center, a 38-story residence; and The Kalakaua Gardens, a multi-story senior living apartment building that is currently under construction. This ART mid-station’s exact location would be across the street from The Hawai‘i Convention Center, on the property holding the address of 1726 Kapi‘olani Boulevard: the current site of two single story commercial structures including Micronesia Mart, a small specialty market, and the gentlemen’s club, Club Rock Za. Land acquisition from these property owners will be required.

### *Waikīkī Segment*

Here, the route will continue over the Ala Wai Canal 0.5 miles to a station located along the canal, just off the intersection between Kalaimoku Street and Ala Wai Boulevard.

To be named the *Kalaimoku Bridge Station*, this mid-station will be constructed on pillars and provide a pedestrian- and bicycle-friendly bridge allowing aerial transit riders to either exit into Waikīkī, or into the Ala Wai Community Park near Iolani school. While providing access to a number of recreational sites in the area, this location is also central to the many residential apartment buildings clustered on the Waikīkī side of the Ala Wai Canal. Therefore, this station is projected to draw a large number of both resident and visitor riders.

From the *Kalaimoku Bridge Station*, the route will continue up and along the Ala Wai Canal to another mid-station along the intersection of Kanekapolei Street and Ala Wai Boulevard. The station here would serve the high residential population living in the surrounding residential high-rises. In addition, many visitors will be expected to utilize this station as it is located three blocks from the newly developed International Market Place, and only a five minute walk to Waikīkī's famed stretch of beaches.

Continuing on from this station, the route will carry on for another 0.5 miles until it reaches the final station terminal, which will be located on the property of Jefferson Elementary School at the end of Ala Wai Boulevard and Kapahulu Avenue. This station would not replace the elementary school, but instead be located on the open, undeveloped area located just next to Ala Wai Boulevard. Thus, only a small portion of the entire school property will require acquisition. The Kapahulu Station would provide access for a large amount of both residents and visitors. The station will serve the adjacent Kapahulu community residents as well as the students attending any one of the schools located within the immediate area. Visitors will also travel frequently to this station as it is located just across the street from The Honolulu Zoo—a historic, 300 acre attraction that draws in many daily visitors. While the zoo has seen a decline in its visitor numbers, the Kapahulu Aerial Station could potentially reverse the decline by providing greater access to its location.

While the Kalaimoku Bridge Station, The Kanekapolei Station, and the Kapahulu Station provide access to Waikīkī down the Ala Wai Canal, a secondary Waikīkī route will branch from the Kalaimoku Bridge Station and travel more directly into the heart of Waikīkī. The alternate Waikīkī route will continue past the Kalaimoku Bridge Station, above Kalaimoku Street, for 0.3 miles, to a terminal station located next the tennis courts near the Aianahau Triangle Park and the Saratoga Post Office. This site is located on the

Ewa side of Waikīkī, along Kalakaua Avenue, and is also only a five minute walk to the beach. Nearly 1/3 of Waikīkī's population resides in this area. Resort towers near this station include Hale Koa Hotel, Trump Hotel, The Halekulani, Luana Waikīkī, and The Maile Skycourt. While a good majority of the resort towers are positioned closer to Diamond Head, this station will act as a mutli-modal access hub, providing easy access to bus routes traveling down both Kalakaua and Kūhīo Avenue. As there are currently no main bus stations in the area, the Saratoga Aerial Terminal station would serve as a prominent gateway point for many visitors entering Waikīkī.

#### *UH Mānoa Segment*

For those riders traveling to and from The University of Hawai'i at Mānoa, they will transfer to the route that branches off of the Kalaimoku Ala Wai Bridge station traveling mauka up University Avenue. The aerial ropeway transit system will have a station at the intersection of University Avenue and Kapi'olani Boulevard—a central location for the many residential households in *Moilili*. The route will then continue 2.5 miles to the intersection of University and South King Street, near Puck's Alley. This particular area provides the highest number of amenities within the closest distance to UH Mānoa. Retail shops, services, and eateries surround this intersection and are frequented by the ever-increasing student and resident populations that constitute the immediate area—as an estimated 4,000 people already live within less than a quarter-mile radius of this intersection\*\*\*(citation). Today, both bicycle lanes and sidewalks along this intersection are perceived as extremely hazardous due to the high volume and average speed of passing vehicles. Thus, an aerial station at this location would provide a safe transition point for bicyclists and pedestrians to extend their route. The address of this station would be 2575 South King Street, which is the current site of a FedEx Office and its parking lot—both of which would need to be acquired.

From this station, the route will continue uphill along University Avenue and traverse up and over the existing powerlines. A support tower will allow the route to pass high above the H1 Freeway to another station that will be located at the entrance of the Stan Sherriff Center. The Stan Sherriff Center sits on the southernmost end of the UH Mānoa—otherwise known as lower campus—just mauka of the H1 Freeway. The dome-



Figure 26: Route Alignment 01  
Source: Made By Author



roofed event center was constructed in 1994 and hosts numerous University sporting events throughout the year. With a capacity of 10,300, the Stan Sherriff Center draws event-goers from all over the island, including many from West O‘ahu. The main entry to the event center is along Lower Campus Road, however, automobile traffic causes extreme automobile congestion along University Avenue and Dole Street: before, during, and after events. There are approximately 2,400 people living within the immediate area—146 households and several multi-story student dormitories—making this location ideal for an ART mid-station, as it will not only help to alleviate heavy traffic congestion, but also allow increased access to the arena. The station will be located just off of the Westbound H1 Freeway off-ramp, where there are currently two portable University offices—both of which will need to be relocated. The station will also act as a turning point to redirect the alignment towards upper campus.<sup>222</sup>

The Stan Sherriff station will allow the aerial route to change angles ever so slightly—by 15 degrees—in order to traverse up and over Lower Campus Road and Bachman Place before the route terminates at the final station. The final ART station will be centrally located on what is now a parking lot for a single story office building in UH Mānoa’s upper campus area. Adjacent to this station site is the Sinclair Library, Hemenway Hall, and the University Campus Center. While each building is heavily used by students, there is little aesthetic value and no common rest space between them. Instead, students and faculty use the asphalt parking area as pedestrian walkways to access the makai building entries. The UH Mānoa terminal will be located only 250 feet from the Sinclair Circle bus stop and bicycling routes, providing an opportunity for a multi-modal access point for both UH affiliates and visitors. Instead of the current parking lot, the proposed aerial terminal will serve as the transportation gateway to UH Mānoa. And, with the clear potential of increased foot traffic, there may also be a renewed interest in improving the quality of this space and its relationship of this area to the rest of the campus. \*\*\*

### *Kaimukī Segment*

ART passengers traveling into Kaimukī will transfer at the station located on South

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<sup>222</sup> "Stan Sheriff Center - Hawaii Athletics", *Hawaiiathletics.Com*, 2008, [http://hawaiiathletics.com/sports/2008/5/14/stan\\_sheriff\\_center.aspx](http://hawaiiathletics.com/sports/2008/5/14/stan_sheriff_center.aspx).

King Street and University Avenue, near Puck's Alley, and board for the proposed route that will travel up South King Street for 0.3 miles to a tall support tower located on the center median in front of the Humane Society. This will allow the route to span above the neighboring residential buildings that are located adjacent to the H1 freeway \*\*off-ramp. This tower would allow the route to angle 10 degrees mauka and traverse high over the H1 Freeway Ramps to the station located near the intersection of Waialae Avenue and Dole Street, which is the current site of a Saab automobile dealership at 3030 Waialae Avenue. The St. Louis Drive and Waialae Avenue intersection is one of larger intersections along this street. Surrounding this intersection are businesses, services, and restaurants that already attract many nearby residents and students that live in the immediate residential neighborhood. Furthermore, the Kapi'olani and Waialae intersection, 500 feet downhill from this station, is heavily used by automobiles as it provides access to the H1 Freeway, which would allow this station to also serve as a safer bypass for both bicyclists and pedestrians.

The route will then continue up and over Waialae Avenue for 0.4 miles to another boarding station at the intersection of Waialae Avenue and 6<sup>th</sup> Avenue. This station will serve transit riders towards the middle of Waialae Avenue at 3282 Waialae Avenue, which is the current location of Servo Toyota Service, next to McDonald's. This location sits near the main roadway that services Palolo Valley residents, thus drawing from a large population of nearby residents. A cluster of educational institutions also surround this site including Aliiolani Elementary School, Sacred Hearts, and St. Patrick's School, with St. Louis School and Chaminade University being only a five minute walk downhill. This station will have multi-modal facilities for riders to efficiently transition to the heavily used bus transit or designated bicycle lane.

From here, the route will continue along Waialae Avenue for 0.5 miles to the final station terminal located on the property of the old Queen Lilioukalani Elementary School, on Waialae and Koko Head Avenue, serving as the prominent station in Kaimukī. Historically, this segment of Waialae Avenue, otherwise known as the *Top of the Hill*, is Kaimukī's activity center and is home to a number of low-rise buildings occupied by many retail shops, banks, restaurants, and other commercial businesses. These amenities draw residents from many of the surrounding neighborhoods by all modes of transit. While



metered and off-street paid parking does exist in the area, finding available spaces can be competitive, especially during peak evening hours.

### 7.3 Route Alignment 02

#### *Ala Moana Segment*

The first alternative alignment would also begin at the Ala Moana Rail Station, on Kona and Kona Iki Street, just mauka of Ala Moana Shopping Center. The proposed aerial terminal will be connected by a walkway to provide rail passengers direct access to the gondola without having to gain reentry. Once again, this route will continue above Kapi‘olani Avenue for 0.6 miles and connect to a station directly across the street from the Hawai‘i Convention Center. The station will be located at 1745 Kalakaua Avenue, the current site of Micronesia Mart.

#### *Waikīkī Segment*

For Passengers wishing to travel into Waikīkī, the route will angle 40 degrees and travel in the makai direction above Kalakaua Avenue to then traverse over the Ala Wai Canal to a station located on the park corner, at the intersection of Kalakaua Avenue and Ala Moana Boulevard. Because development in Waikīkī is fairly dense, with numerous residential and hotel towers clustered throughout the area, this particular location is one that especially open and spacious. Furthermore, the open park, as it currently stands today, actually creates a pedestrian divide. This station will be directly adjacent to the Asia-Pacific Center, and draw people from the many hotels and residential apartments located on the Ewa end of Waikīkī. Thus, this terminal will serve as the gateway station to Waikīkī and act a major multi-modal transportation station, as many bus routes and bicycles paths also already converge at this location.

From this station, the route will then angle 15 degrees, towards Diamond Head, and continue over and along Kūhīo Avenue, for 0.6 miles, to a station terminal on Kanikapolei Street. Due to the nature of aerial transit, the route alignment requires a turning station on the intersection of Kanikapolei Street and Kūhīo Avenue—a prominent intersection in Waikīkī—in order to adjust for the slight bend on Kūhīo Avenue. Adjacent to this site is the

Ohana Waikīkī Hotel, and several other single story commercial buildings with numerous other small retail shops and restaurants. An open landscaped parklet occupies one corner of the intersection, along with seating and a heavily used bus stop. The station will also service the nearby mid-rise residential apartment buildings along Kanekapolei and Kaiulani Avenue, just one street over. Because of the building density and angle of Kūhō Avenue, the station would be constructed partly over the intersection and would require partial land acquisition on 2370 Kūhō Avenue—the current location of several small eateries.

The slight turn in Kūhō Avenue will again require another intermediate turn station. This Lilioukalani Station will be located partially above the intersection of Lilioukalani and Kūhō Avenue, and will need property acquisition from the single story commercial business building—160 Lilioukalani Avenue—on the corner. This station will provide a 10 degree turn down Kūhō Avenue towards the Honolulu Zoo. Though several resort hotels currently occupy the intersection corners, this station is likely to see a much larger residential population as several mid-rise apartments and homes line the mauka end of Lilioukalani Avenue and Ohua Avenue. Lilioukalani Avenue also runs perpendicular to Kūhō Beach, providing only a three minute walk from the aerial station to the water.

The route will continue along Kūhō Avenue from the Lilioukalani Station to the Kapahulu Station, which will be the final end point for this route alignment—situated at the Diamond Head end of Waikīkī. This terminal will be located on the existing zoo parking lot along Kapahululu Avenue. Because this arterial roadway serves many bus routes, automobiles, and bicycles, this station terminus will provide facilities for a seamless multi-modal transition experience for people traveling into and/or exiting Waikīkī. Furthermore, this location is one of the major access points into Waikīkī, so many visitors, as well as residents from the adjacent neighborhood are expected to utilize the station. Major nearby amenities include the Honolulu Zoo, The Shell Concert Hall, Kapi‘olani Park, and Queens Beach—all of which attract thousands of visitors daily. Several businesses also line the makai end of Kapahulu Avenue.

#### *UH Mānoa Segment*

For riders that choose to travel to UH Mānoa, their route will continue along



Figur 27: Route Alignment 02  
Source: Made By Author

Kapi‘olani Boulevard, from the Hawai‘i Convention Center, traveling 0.6 miles towards the turn station at the University and Kapi‘olani intersection. Here, passengers can either exit to the Ala Wai Park and surrounding neighborhood, or remain on the route which then turns 45 degrees mauka up University Avenue. Similar to Route Alignment 01, there will be stations located near Puck’s Alley, the Stan Sherriff Center, and UH Mānoa’s upper campus.

#### *Kaimukī Segment*

To access Kaimukī from the aerial network, the route would continue eastbound above and along Kapi‘olani Avenue, from the Kapi‘olani and University transfer station, for another 0.4 miles, arriving at a support tower located in the center median of Kapi‘olani Boulevard. This support tower would provide an angle change for the aerial alignment, following the slight curve in Kapi‘olani Boulevard, and thus allowing the route to continue to a station located across the street from Kaimukī High School and Market City Shopping Center—a small commercial area with approximately 20 businesses that draw residents from the Moilili, Kaimukī, and Kapahulu neighborhoods. The station’s central location, at the makai end of Kapahulu, will provide direct multi-modal access to many of the other businesses that line this arterial roadway. From the Market City Station, the route will traverse over the H1 Freeway Ramps and above the powerlines to a station located on the intersection of Waialae and 1<sup>st</sup> Avenue—the current location of a Saab automobile dealership. This route will then continue up Waialae Avenue with stations located at Waialae and 6<sup>th</sup> Avenue—the current location of the Servco Toyota Parking Lot—and a final station located on the property of the old Queen Lilioukalani Elementary School, at the intersection of Waialae and Koko Head Avenue.

### 7.4 Route Alignment 03

#### *Ala Moana Segment*

The second alternate alignment will also begin at the Ala Moana Rail Station, at the Kona Street and the Kona Iki Street intersection, adjacent to Ala Moana Shopping Center. The aerial station will be designed to work in full colaboration with the rail station,

allowing passengers a smooth transition between transportation modes without any need for reentry. This route will continue up the center of Kapi‘olani Boulevard, to a station across the street from the Hawai‘i Convention Center. The route will then continue along Kapi‘olani Boulevard for another 0.6 miles, where Kapi‘olani Boulevard and University Avenue intersect, providing the best opportunity for aerial transit to redirect passengers either to Waikīkī or UH Mānoa. The Kapi‘olani Station will be located right near Ala Wai Park: an area with a high residential population—approximately 6,000 people—due to the residential community mauka of Kapi‘olani Boulevard, as well as the high-rise apartments on the makai side of Kapi‘olani Boulevard. This intersection is also located near Iolani and Ala Wai elementary schools. This station would be supported above the intersection, and partly over the Ala Wai Plaza property corner, being a transition point from which passengers could transfer to a final destination either at the University of Hawai‘i or in Waikīkī.<sup>223 224</sup>

#### *Waikīkī Segment*

For passengers continuing into Waikīkī, the route would continue makai of the University and Kapi‘olani intersection and traverse over the Ala Wai Canal into Waikīkī. Once in Waikīkī, the system would route over Kalaimoku Street to the tennis courts, near the Saratoga Post Office, adjacent to Kalakaua Avenue.

#### *UH Mānoa Segment*

For riders that choose to travel to UH Mānoa, their route will continue along Kapi‘olani Boulevard, starting from the Hawai‘i Convention Center, and travel 0.6 miles toward the turn station at the University Avenue and Kapi‘olani Boulevard intersection. Here, passengers can either exit to the Ala Wai Park and surrounding neighborhood, or remain on the route which then turns 45 degrees mauka, and travels up University Avenue. Similar to Route Alignment 01, there will be stations located near Puck’s Alley, the Stan

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<sup>223</sup> "Honolulu Aerial." Honolulu Aerial. Accessed September 18, 2016.

<http://www.honoluluaerial.com/written-route.html>

<sup>224</sup> "Manoa Neighborhood in Honolulu, Hawaii (HI), 96813, 96822 Detailed Profile." Manoa Neighborhood in Honolulu, Hawaii (HI), 96813. Accessed December 08, 2016. <http://www.city-data.com/neighborhood/Manoa-Honolulu-HI.html>.





Figure 28: Route Alignment 03  
Source: Made By Author

Sherriff Center, and UH Mānoa's upper campus.

### *Kaimukī Segment*

The Kaimukī segment will remain the same as alternative alignment 01: passengers will transfer from the Kapi'olani Boulevard and University Avenue mid-station, continue up Kapi'olani Boulevard for 0.5 miles to the Market City Station, and then traverse 0.25 miles over the H1 Freeway to the Waialae Gateway Station located at the intersection at Waialae Avenue and Dole Street. The alignment will then continue 0.4 miles to the intersection at Waialae and 6<sup>th</sup> Avenue, across the street from Sacred Hearts Academy and Aliiolani Elementary School. The route will then terminate at the intersection of Koko Head Avenue and Waialae Avenue, on the corner property where the old Queen Lilioukalani Elementary School currently sits.

## 7.5 Route Assessments

Each route presents its own specific benefits and drawbacks to the community, making it especially challenging to choose one route alignment over another. In order to make this decision, an analysis was needed in order to review the various benefits and drawbacks of each route. A matrix was therefore constructed to evaluate several factors including issues related to site, the community, and the existing multi-modal transit network. The issues were then identified and weighted with a numerical value from 1 to 5, with 1 being the least important and 5 being the most important. Next, a score was given based on how well each route dealt with each of the corresponding issues, and that score was then multiplied by the weighted value of that issue. After a full evaluation, the final values for each route were tallied, and the score was used to determine which route would benefit Honolulu the most. After analysis of each route's issues, it was evident that scores were very similar to one another. However, Route Alignment 01 prevailed due to its high scores in community accessibility and potential for development opportunities. Thus, Route Alignment 01 was chosen as the proposed route for this study.

Issues		Route Alignments			Weighted Total			Rating	
		Route 1	Route 2	Route 3	Weighted Total: Route 01	Weighted Total: Route 02	Weighted Total: Route 03		
Route Issues	Issue Weighting (1-5)							Good	2
								Fair	1
								Not Applicable	0
								Minor Problems	-1
								Major Problems	-2
Community Accessibility	5	2	2	1	10	10	5		
Demand	5	2	2	1	10	10	5		
Population Density	3	2	2	1	6	6	3		
Available Land	3	1	-1	2	3	-3	6		
Route Views	3	2	2	1	6	6	3		
Affected Existing Views	2	1	1	1	2	2	2		
Nearby Station Amenities	2	2	2	1	4	4	2		
Multi-Modal Integration	4	2	2	1	8	8	4		
Economic Impact	5	2	2	1	10	10	5		
Future Route Expandability	3	2	2	1	6	6	3		
Constructability	3	-1	-1	1	-3	-3	3		
Cost	4	-1	-1	1	-4	-4	4		
Total		16	14	13	58	52	45		

Table 12: Route Evaluation Matrix

Source: Made by Author

The issues and how they were weighted is described below:

### *Community Accessibility*

Community accessibility describes how well the route and station placement will be accessed by nearby residents. Stations placed in close proximity to neighborhood centers that already possess adequate and existing pedestrian, bicycling, and roadway infrastructure, will receive a higher rating, especially if current transportation options are less than ideal. For example, Route Alignment 01 and 02 span longer distances than Route Alignment 03, so route 01 and 02 received higher matrix scores. Furthermore, community accessibility was seen as a critical issue and given a high weighted value of 5.

### *Demand*

Demand describes how much desire there is by residents to use public transit. In



areas such as Ala Moana or Waikīkī, there is a higher demand for public transit, as a higher percentage of people within the area do not own private automobiles. This issue category was given the highest rating of 5, as a higher demand will support the ART system financially and lead it to long-term success.

### *Population Density*

Population density describes the number of people that live within an area. Transit routes that pass through more densely populated areas, and/or stations that are located in such areas, have the increased potential to succeed because there are already a high number of people currently present within the immediate area. Areas with higher population densities also have the potential to increase the willingness of individuals who would not normally use public transit due to the close proximity of the station.

### *Available Land*

By nature, when compared to rail transit systems, the ART system will require less land to construct upon, as the footprints for support towers are fewer than footprints for rail guideways. The available land category can be defined as the amount of space that is available for support tower placements, route alignment paths, and space for station placements. A number of factors can affect whether land is available or not, which can include zoning rules, property ownership, land parcel division lines, history of the site, as well as adjacent site uses. A longer route will guarantee that more land for infrastructure will be needed. If land is unavailable or privately owned, property acquisitions will be needed, greatly increasing the cost of the overall project.

### *Views*

The views category represents the quality of the passenger's view from inside the ART cabin. The unique transit experience that ART offers is one of the defining characteristics of the system, and is also a main driver in attracting long-term ridership from residents and tourists alike. Quality views will be prevalent on routes that travel along water, have little to no view obstructions, and are higher above ground level. This category was therefore given a substantial rating value of 3.

### *Nearby Amenities*

Neighborhood amenities—including grocers, shops, restaurants, cafes, parks, gyms, theaters, schools, etc.—are extremely important when determining the value of ART and its potential success. Transit stations located in areas that have a large amount of nearby amenities will most likely draw in riders to the area. However, if the nearby area is already saturated with amenities, there may be little room for further growth or development. Conversely, stations located in areas with little to no nearby amenities may struggle to attract new transit riders. Locations that have nearby amenities and are not yet fully saturated with them stand to benefit the most, as development potential will attract new investment interest. When comparing stations between each route, many are located at very similar locations and have moderate to high levels of nearby amenities. Therefore, the weighted rating for this category was given a 2 point value.

### *Multi-Modal Integration*

Multi-modal integration describes how well the route and transit stations will be able to tie into the existing transit network. To support ART and its long-term success, the entire transit experience from an origin to a destination needs to be as fluid as possible, reducing inconveniences such as long walks to bus stops or lack of bicycle storage. Achieving successful multi-modal integration primarily depends upon the transit station location: if it is along key transportation routes, integrated into safe bicycle lanes, and located near quality pedestrian pathways. As ART is a system aimed at promoting more sustainable movement throughout the city, having routes with station locations that support the transportation hierarchy will receive higher scores on the matrix. Therefore, this category was given a higher weighted value of 4.

### *Economic Impact*

ART's economic impact, or development opportunity, refers to how well the system will potentially improve a community's economic state. Existing development strategies, such as Transit Oriented Development plans, have proven that new transit systems integrated within existing communities can greatly benefit that area—particularly

the area that falls within a 0.5 mile radius around the station itself—if properly planned and implemented. While each route greatly increases connectivity between Waikīkī, Ala Moana, UH Mānoa, and Waialae Avenue, route alignment strategies that are longer will circulate larger amounts of people and potentially increase capital and investment interest around more transit stations. Since transportation can act as a catalyst for social and economic improvement, the category was given a high weighted rating of 5.

#### *Future Route Extensions*

As urban development and population density continues to rise, it is important that transportation systems adapt in order to maintain circulation within Honolulu. Much of O‘ahu’s current transportation issues, including congestion, rail challenges, and lack of bicycling as well as pedestrian infrastructure are due to insufficient urban planning. A city whose transportation network does not adapt with urban growth will find itself facing critical problems in the future. Therefore, a certain level of planning is needed to be made in order to anticipate growth. Fortunately, ART systems are simpler to expand than other transit systems, such as heavy rail, because more cabins can be implemented along a route at any time, and less infrastructure is needed for route extensions. In this category, route alignments are valued based on their ability to be extended. Route Alignments 01 and 02 both traverse along Waialae Avenue and currently end at the Koko Head Intersection; however, it would be relatively simple to continue the the route down Waialae Avenue, nearing Kahala Mall, as Waialae Avenue is fairly straight and the Kokohead Station is on a parcel of land large enough where construction would be less disruptive to the surrounding community. Alternatively, Route Alignment 03 is shorter and would not have the opportunity to expand much further beyond its current station placements.

#### *Affected Existing Views*

While ART has the ability to provide sweeping views of the surrounding environment, and crossover challenging topography and obstacles, it can only do so by being suspended high above ground level. Integration into an urban environment will inevitably lead to some views being affected, especially those belonging to residents living in high-rises adjacent to the ART system. Integration near taller residential buildings

should be avoided if possible; however, due to site limitations, this may be unavoidable. For instance, Route Alignment 01 travels along the Ala Wai Canal. And though this alignment has high quality views of the mountain range, some residential apartments along the canal will have views that may be affected by ART infrastructure. For example, Route Alignment 02's routes that aim to limit the amount of affected views will score higher on the matrix than the routes that do not.

### *Constructability*

The constructability category represents the level of difficulty regarding the construction of a route's towers and stations. For example, Route Alignment 01 will need to be built alongside the Ala Wai Canal, which may prove challenging, while other stations will have open parcels of land to construct on. Construction near the canal will need careful planning and phasing to ensure the structural integrity of the canal is preserved, which may potentially increase project costs. It is important to also consider that, while most site locations are relatively flat, nearly every site within Honolulu is surrounded by arterial roadways. This may lead to traffic build-up during construction and contribute to longer construction times and cost. As an important issue that greatly affects the project's cost, this category was weighted with a value of 3.

### *Cost*

The cost for each route is based on number of complex variables: the amount of land acquisition needed, materials and labor costs, planning and design costs, as well as the potential for problems to arise. All of these variables factor into the overall costs of the project, which still needs to maintain sufficient long-term ridership. Generally speaking, the shorter the route and the less design attention the ART system receives, the lower the overall cost will be. However, lowering certain costs may threaten the success of the system, as ridership may remain low. As Hawai'i's rail project has a current cost that is nearly twice that of what the project was initially proposed as, a lower cost transit system will be favorable to the community. For instance, Route Alignment 03 traverses the shortest distance, yet it does not provide the same level of access to certain parts of the community as Alignment Routes 01 and 02 provide. This is an extremely important issue and needs to

be carefully considered. Therefore, the cost category receives a high weighting value of 4.

#### *Route Alignment 01: Proposed*

One of the major differences of this route, when compared the other two routes, is that it creates the greatest amount of access to Waikīkī—a fundamental principle to supporting a TOD plan. Instead of routing into Waikīkī’s development, this route provides access at different stations along the Ala Wai Canal. This means that stations would be not as constricted within the surrounding building density, and can thus provide a more comfortable platform for passengers to board and alight the system.

The Kalaimoku Bridge Station, located above the canal, provides the opportunity to create a pedestrian- and bicycle-friendly bridge, which means that access over the Ala Wai is not limited to aerial transit. Additionally, the Waikīkī segment of Route Alignment 01 extends to the Diamond Head end of Waikīkī, and into the Ewa end of Waikīkī. Though the route does not travel directly through Waikīkī’s hotel development along Kūhīo Avenue, the beach and majority of the surrounding businesses are easily accessible by only a four minute walk.

While this route still extends into Kaimukī, one drawback is that it does not stop at the Market City Shopping Center. Instead, access into Kaimukī begins at the University and King Street Transfer Station, traveling over H1 Freeway to Waialae Avenue. However, the lack of a direct connection to the Market City Shopping Center was not determined to substantially weaken the connectivity to Kaimukī, as individuals can walk from the Waialae Gateway Station to the Market City Shopping Center in three minutes.

It should be noted that one of the major challenges when constructing above ground transit, specifically in Kaimukī, is the presence of the above-ground powerlines located above and all along Waialae Avenue. The proposed ART route relies on Kaimukī’s future plans to run the above-ground powerlines underground—from Kapi‘olani and Waialae intersection, to the Koko Head and Waialae intersection.

#### *Route Alignment 02: Alternative*

While Route Alignment 02 still maintains strong connectivity between each destination, this route travels more directly into Waikīkī’s hotel development and more

effectively connects the Ewa and Diamond Head ends of the neighborhood. Starting at the Ala Moana Station, the route continues past the Hawai‘i Convention Center. However, its path follows Kalakaua Avenue to the Kalakaua Gateway Station, at the Ala Moana Boulevard intersection. The route then traverses down Kūhīo Avenue—one of two major streets lined with businesses and hotels in Waikīkī—before finally reaching the Kapahulu Terminal Station, located near the Honolulu Zoo. While traveling down Kūhīo Avenue will be more challenging due to the building density and privacy issues, the route circulates passengers more directly into Waikīkī, thus more conveniently serving both the residents and visitors in the immediate area.

However, the primary drawback of Route Alignment 02 is the lack of connectivity over the Ala Wai Canal. While there remains a direct path to UH Mānoa and Waikīkī from Ala Moana Station, the connection between Waikīkī and UH Mānoa is weakened as there is no access directly over the Ala Wai Canal. Passengers could still travel to UH Mānoa from Waikīkī, however they would need to travel back to the Hawai‘i Convention Center Transfer Station to then re-route towards UH Mānoa.

The route also differs from Route Alignment 01 because passengers traveling to Kaimukī from Ala Moana will need to transfer from the University and Kapi‘olani Transfer Station instead of at the University and King Street Station. Transferring from this location allows for the opportunity to place a station at the Market City Shopping Center next to Kaimukī High school. Adding this connection along the route to Kaimukī more effectively allows access of the system.

#### *Route Alignment 03: Alternative*

The Route Alignment 03 alternative maintains a connection between Ala Moana, Waikīkī, UH Mānoa, and Kaimukī; however, the aerial route into Waikīkī is not as extensive. When traveling from the Ala Moana Station, passengers that need to travel into Waikīkī can traverse over the Ala Wai Canal, from the University and Kapi‘olani Transfer Station to the Saratoga Station along Kalakaua Avenue—this creates stronger access to many of the surrounding hotels and apartments. However, by not extending the length of Waikīkī, convenient access to the Saratoga Station will be less convenient.

## 7.6 Route Extensions and Reductions

This research originally proposed reconnecting Ala Moana, Waikīkī, UH Mānoa, and Kaimukī. However, as this research progressed, it became apparent that the ability for future route extensions should be explored. As mentioned previously, the ability for a city's transportation system to expand and evolve alongside development and population growth is imperative to maintaining sustainability and a high quality of life. Much of O'ahu's urban transportation problems are caused by little to no expansion of roadways, mass transit infrastructure, and pedestrian infrastructure. Consequently, O'ahu now faces high costs for constructing an elevated rail system that needs to traverse through dense urban development, leaving the city's most important economic and neighborhood centers disconnected from the urban core.

With the possibility that ART will be implemented throughout Honolulu, it is necessary to discuss a potential route extension. One extension that could be implemented at a later phase, and still provide improved connectivity to the urban core, would be the extension of the Kaimukī segment toward a station terminating at The Kahala Mall—a small shopping center located just past the Eastern end of Waialae Avenue. While this shopping center is only a fraction of the size of the Ala Moana Shopping Center, this economic node is central to the surrounding area—otherwise known as the Waialae-Kahala neighborhood. The enclosed, 464,000 square foot shopping center contains 101 businesses—retailers, restaurants, a grocery store, boutiques, service shops, and a movie theater—attracting thousands of residents visitors every week.<sup>225</sup> Additionally, the shopping center is a key destination along TheBus routes, further suggesting that there is already a high demand for public transit to and from this location.

The next figure outlines the potential route extension from the Koko Head Terminal Station towards Kahala Mall. And, because Waialae Avenue provides a somewhat straight path towards Kahala Mall, traveling to its terminal station will be both quick and direct. A new drive system will need to be installed in order to allow the route to continue down

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<sup>225</sup> Kamehameha Schools Commercial Real Estate," Kamehameha Schools Commercial Real Estate, , accessed February 18, 2017, [http://www.ksbe.edu/commercialrealestate/commercial\\_properties/commercial\\_kahala\\_mall/](http://www.ksbe.edu/commercialrealestate/commercial_properties/commercial_kahala_mall/).

Waialae Avenue, for 0.9 miles, toward several support towers located on Waialae Avenue. The route extension will then end at a terminal station located on the parking lot corner at the Kilauea Avenue and Waialae Avenue intersection, near the bus stop, and adjacent to Kahala Mall.

Alternatively, a shortened variation of each route should also be explored as a lower cost alternative. Since Waikīkī and UH Mānoa support a higher number of employment opportunities and draw more residents than Kaimukī, the Kaimukī segment of ART could potentially be eliminated, leaving route alignments connecting only Ala Moana, Waikīkī, and UH Mānoa. While Waialae Avenue in Kaimukī can greatly benefit from a TOD plan supported by ART, there are aspects that make running an alignment to the area challenging.

In terms of route alignment, the Kaimukī segment alone is nearly 2 miles, which is longer than half of the total alignment length. A route to Kaimukī would also require two separate angle turns and additional towers before the alignment could run along Waialae Avenue, thus requiring even more mechanical equipment to be installed. While this route is possible, it would ultimately increase both the visual presence and the overall cost of the project.

The longer route length may also create concern among residents as it traverses near many single-family residential homes and apartments. The Kaimukī segment along Route Alignment 01, between the Pucks Alley Station and Waialae Avenue's Gateway Station, traverses near a high-rise and mid-rise apartment building located next to the H1 Freeway ramps. While there is clearance for the route alignment's 60' right-of-way, the closer proximity will most likely raise concern with these two apartment buildings. The Kaimukī segment of Route's 02 and 03 do not travel as close to these apartment buildings as in Route 01; however, there are several high-rise residences along Kapi'olani Boulevard whose views may slightly be affected.



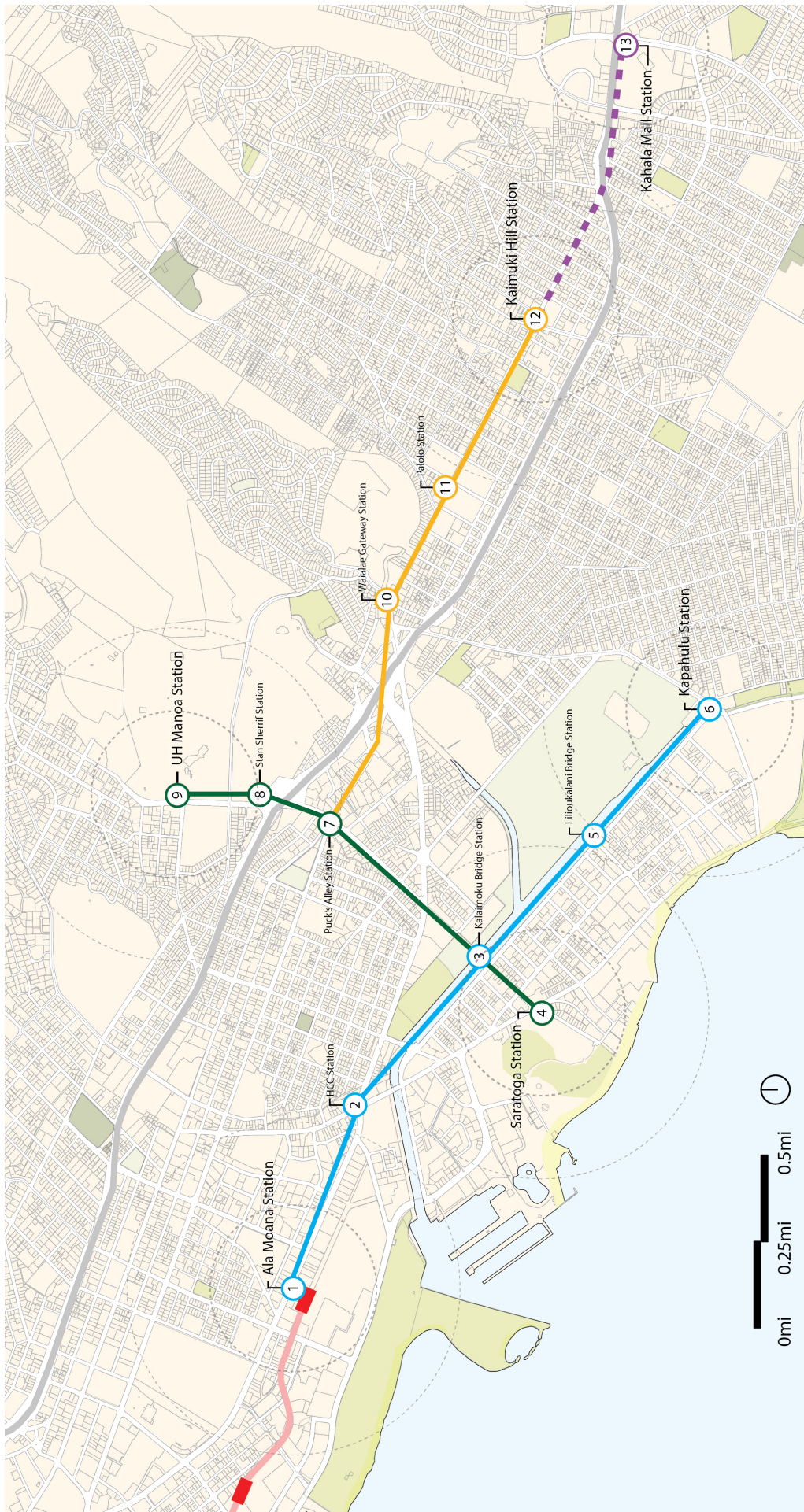


Figure 29: Route Alignment 01 with Kahala Station Extension  
Source: Made By Author

Route Proposals			
	Route Alignment 01	Route Alignment 02	Route Alignment 03
Length	5.4	5.7	4.6
Terminal Stations	5	4	4
Mid-Stations	7	10	7
Shortened Route Proposals - No Kaimukī Extension			
	Route Alignment 01	Route Alignment 02	Route Alignment 03
Length	3.7 (-32%)	3.75 (-35%)	2.7 (-42%)
Terminal Stations	4	3	3
Mid-Stations	5	7	4
Table 13: Comparison between proposed routes and shortened proposed routes. Source: Made by Author			

## Overall

While each route varied slightly in their paths, all provide the additional access and mobility needed to support the transportation hierarchy, provide better access between destinations, and strengthen the overall connectivity within the urban core—all important principles when supporting a TOD policy. Based on the assessment of each route, Route Alignment 01 was determined to provide the greatest benefits to the city by addressing the most issues identified in the connectivity analysis, including providing access across the Ala Wai Canal and strengthening access between the Ewa and Diamond Head ends of Waikīkī.

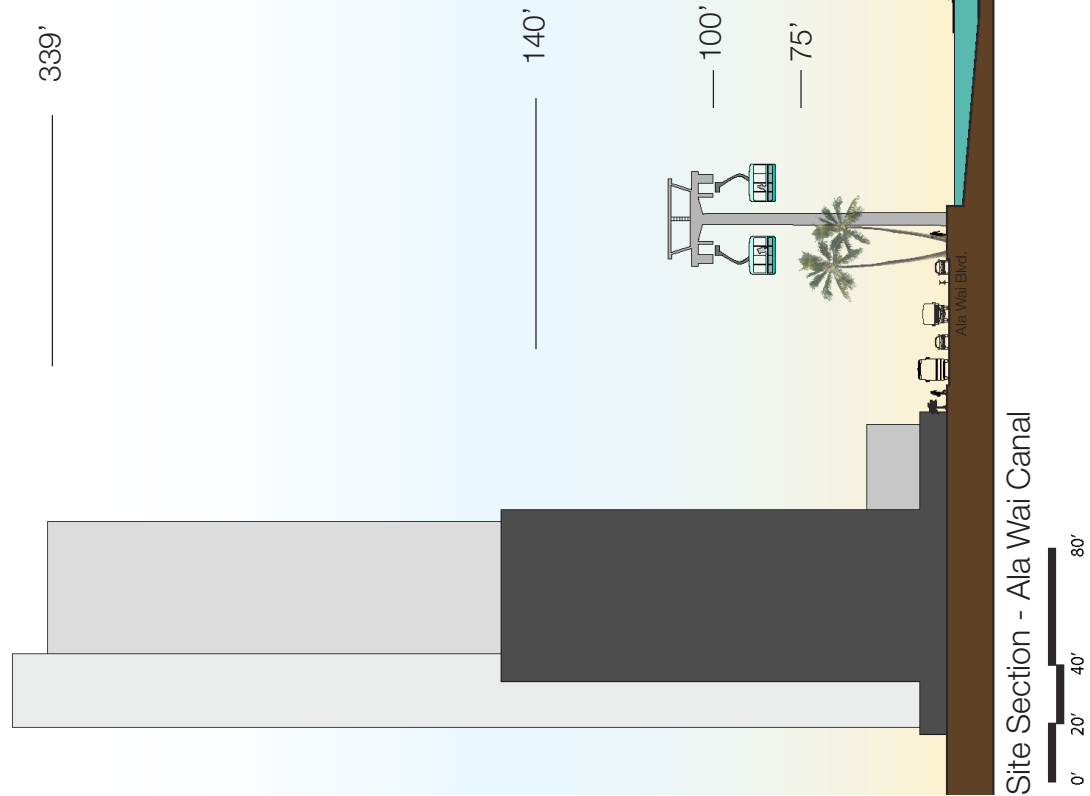
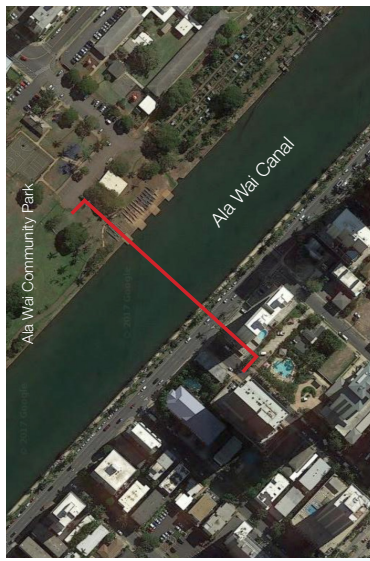


Figure 30: Ala Wai Canal Site Section  
Source: Made By Author



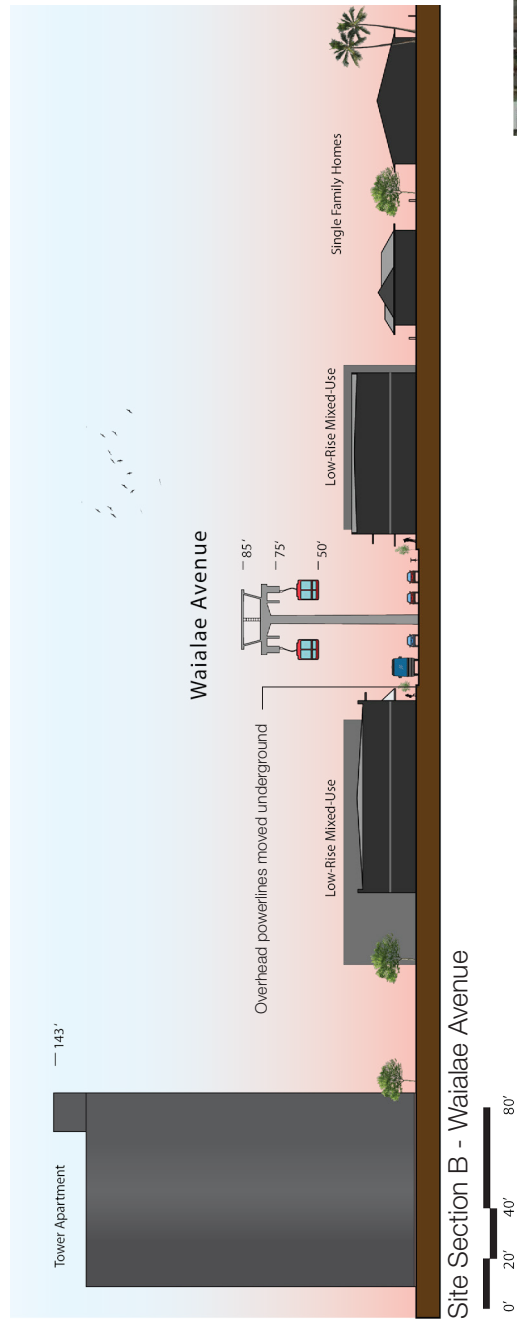
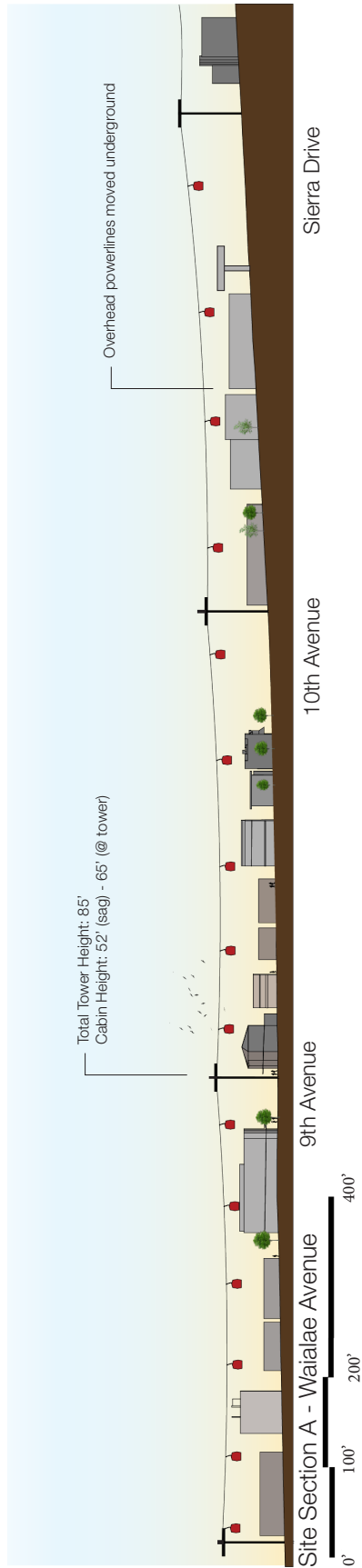


Figure 31: Waialae Avenue Site Sections  
Source : Made by Author



Figure 32: Ala Wai Canal Segment - Route Alignment 03  
Source: Made By Author





Figure 33: UH Manoa Segment - Route Alignment 01, 02, and 03  
Source: Made By Author



Figure 34: Waialae Avenue, Kaimuki Segment - Route Alignment 01, 02, and 03

Source: Made By Author

## 8.0 Case Studies

Aerial ropeway transit has been utilized in many parts of the world for recreational purposes, as well as for public transit in urban settings. In the past decade, countries in Europe, Asia, and South America have utilized this system in response to many of the urban-related challenges that are arising in urban centers all over the world, with one of those places being Honolulu. Traffic congestion, geographical boundaries, and building development, as well as a lack of adequate connections to urban destinations, are all issues that have been mitigated with aerial ropeway transit. In proposing an aerial public transit system, it is important, therefore, to understand how and why other cities have implemented the service, to then determine if it is a feasible transportation system for O‘ahu. This section provides examples of systems that share some of the same opportunities and challenges as Honolulu. This section also describes the impact that implementation has had on the communities that surround already-present aerial ropeway transit systems, allowing for a better understanding on how to approach implementation here in Hawai‘i.

Though it is important to understand that successful examples of aerial transit exist in other urban developments, it is most important to understand the commonalities that exist between Honolulu and the case studies being assessed, in order to understand how other cities have approached similar challenges and what the impacts were. The three case studies that were chosen, are, the Medellin Metrocable in Colombia, the Mi Teleferico in Bolivia, and The Caracas Metrocable in Venezuela. While these location are unique, each using different approaches to their planning and construction, these case studies exist in warm climates and possess similar geographic, transportation, and development boundaries that caused disconnections, which lead to potential opportunities within their respective urban communities. Therefore, these cities were found to share the same goals in creating safe, efficient, and direct modes of access between communities, while opening economic and development opportunities in the surrounding areas.



## 8.1 Medellín, Colombia – Metrocable

Medellín is currently the second largest city in Colombia and is located in the center of the Aburra Valley. This thriving city has a growing population of approximately 2.2 million people. Geographically, the city itself lies along the center of a valley and is surrounded by dense hillside communities consisting of 1-2 story houses. While the city had existing public transit, it mainly provided access only along valley center. The hillside neighborhoods including Santo Domingo and San Javier had winding roadways with heavy traffic congestion and inadequate bus transit.<sup>226</sup>

Currently, however, Medellín has seen a period of social and economic improvement based on new social policy and a new transportation system. Rapid development inclusive of new high-rises, businesses, and restaurants have emerged throughout the city. And it was only a decade ago that Medellín was experiencing a period of social and economic hardship rooted in its past history of drug trafficking and violence. During this time, infrastructure and development had become run down, communities had become poverty stricken, and the city's youth would frequently join violent gangs for social status and survival. However, in 2007 the city made an enormous effort to improve the social and economic well-being of the community by setting in place a policy for its recovery. The main premise of this recovery policy was to recover the public spaces within the city, and strengthen institutions by providing greater access to education and employment centers. A major portion of this policy, known as the Plan Urban Integral or Integrated Urban Plan, aimed to strengthen the city by improving transportation and public infrastructure, especially in areas of recreation and leisure.<sup>227</sup>

A main portion of this policy was to construct a new transit system that effectively connected with the existing bus and rail metro to ensure that the new transportation system would be as effective as possible. The city looked to new technologies that would provide it the most social and economic benefits. Due to dense neighborhood development,

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<sup>226</sup> JACOBS, *Aerial Cable Transit Feasibility Study* (Miami: Miami-Dade Metropolitan Planning Organization, 2016), 33.

<sup>227</sup> Coby Joseph, "Medellín Metrocable Improves Mobility For Residents Of Informal Settlements | Thecityfix", *Thecityfix*, 2014, <http://thecityfix.com/blog/medellin-metrocable-improves-mobility-informal-settlements-low-income-accessibility-equity-development-coby-joseph/>.

challenging geography, and low overall cost, Medellin chose to implement aerial ropeway transit as a means to improve urban mobility. Known as the Metrocable, the system was designed to provide quick, convenient, and direct transportation for residents in dense hillside neighborhoods just above the downtown Medellin. The area uses three Metrocable lines—Line J, K, and L—to span several miles of dense neighborhood development, with main stations anchored at prominent geographic locations.<sup>228</sup>



Figure 35: Medellin Metrocable.

Source: GondolaProject<sup>229</sup>

Line K, constructed in 2004, was the world's first aerial ropeway to be utilized as a public transportation system; it has also been considered as the most successful. This system route spans 1.25 miles long with 4 stations that services the Santa Cruz, Popular, and Santo Domingo neighborhoods located above the downtown area. The gondola utilizes monocable detachable gondola technology, and each of its suspended cabins support up to

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<sup>228</sup> Ibid.

<sup>229</sup> "Medellin-Metro", *Gondolaproject*, 2010, <http://gondolaproject.com/wp-content/uploads/2010/03/Blue-Skies-Everywhere-copy.jpg>.

10 people, which most times operate at full passenger capacity. At a cost of only \$24 million, the implementation of this system was inexpensive relative to its overall effectiveness.<sup>230</sup>

One of the major benefits of Line K is its full integration with the city's bus and rail metro systems that service downtown Medellin. This allows the resident's neighborhoods much better access to schools, jobs, and recreational areas that were once very difficult to access because of the geography and indirect roadway network. The increased access has also helped to improve commerce and economic development along the route alignment. With increased capital and commerce circulating through the area, new developments and businesses have been emerging along the aerial route.<sup>231</sup>

One drawback of this route is that it experiences a higher ridership than it was initially designed for. While the Santo Domingo station was strategically placed to service the large number of residents in the area, demand for the lower capacity MDG system was much higher than anticipated. Many riders using the system were from outside of the rider catchment system and utilized the Line K because of its efficiency through Medellin. However, with no expandability options designed into the current station, it is not possible to increase the number of cabins or their individual capacity. As a result of such high demand, Metrocable users are forming queues, which are only increasing their overall commute time.<sup>232</sup>

Line J, constructed in 2009, is also a MDG system that serves the hillside communities in the San Javier district, including the residential barrios of La Aurora and Vallejuelos. This route alignment was also designed to connect passengers to the San Javier Rail Station, where passengers could then connect to the large mass transit station to travel to places of education, recreation, and/or employment, at greater distances. Because of the winding streets and dense single story households in the area, traveling downhill would typically take over an hour. However, the Line J Metrocable is able to make the same trip in about 10 minutes.

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<sup>230</sup> Steven Dale, "Medellin/Caracas, Part 2 « The Gondola Project", *Gondolaproject.Com*, 2010, <http://gondolaproject.com/2010/03/12/medellincaracas-part-2/>.

<sup>231</sup> Ibid.

<sup>232</sup> Ibid.



Figure 36: Medellín Metrocable Map.

Source: GondolaProject<sup>233</sup>

Economically, the Line J has also substantially improved the areas surrounding the barrios. Steadily increasing ridership has allowed many people to find employment just beyond the gondola system, which has helped to bring more money into the surrounding neighborhoods. Before the implementation of Line J, homes were in constant disrepair. However with the increased access and opportunity to capital, new houses, businesses, and public areas have begun to emerge around Line J.<sup>234</sup>

While Line J and K operate primarily to serve residents traveling to economic

<sup>233</sup> "Medellin-Metro", *Gondolaproject*, 2010, <http://gondolaproject.com/wp-content/uploads/2010/03/Medellin-Metro-copy.jpg>.

<sup>234</sup> Ibid.

centers from their homes, Line L serves both tourists and residents. This alignment route, constructed in 2010, serves as an extension for Line K, extending past the Santo Domingo Station, traveling to the Parque Arvi—an ecological nature preserve that is also one of the city’s major tourist destinations. Because access to the park was previously only accessible by car, which majority of people do not have, most residents were unable to travel to the area. The implementation of this new aerial alignment now allows residents to easily enjoy all of the recreational areas nearby.<sup>235</sup>

Though implemented primarily as a transportation system, the Medellin Metrocable has become a focal point for the entire city, especially in the neighborhoods it services. The areas surrounding the aerial route has seen a focused effort by the city and its residents to improve housing, schools, and public spaces. Increased access to commerce has helped new small businesses emerge, further drawing residents to the area and increasing the neighborhoods liveliness. To the relief of many residents, Medellin has also seen an enormous decrease in violent crimes due to the increased law enforcement, new public lighting systems, and public presence in the area.<sup>236</sup>

Overall, the MetroCable in Medellin, Colombia was chosen as a precedent study because it shares similar challenges and opportunities that Honolulu is currently facing, though to a lesser degree. These challenges include being located in a highly developed urban environment, having economic and commercial opportunities, facing increasing roadway congestion, having public transit used by both residents and visitors, the need to traverse of over private and public buildings, and needing to extend the reach of existing public transit. While Honolulu does not share the same level of severe social and economic issues as Medellin, this city’s experience exemplifies how strengthening connections around the urban core through alternative and novel infrastructure can help to strengthen the overall urban fabric and improve the quality of life of residents in disconnected areas. Taking a risk with implementing an alternative public transit system, as seen in Colombia, could potentially help Honolulu to create a more connected urban core through increased mobility and greater economic and social gains.

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<sup>235</sup> Ibid.

<sup>236</sup> Coby Joseph, "Medellín Metrocable Improves Mobility For Residents Of Informal Settlements | Thecityfix", *Thecityfix*, 2014.

## 8.2 La Paz, Bolivia – Mi Teleferico Gondola

La Paz, Bolivia is another city that has used aerial ropeways as a means to strengthen its urban core. With a population of approximately 2.3 million people, the city has an elevation greater than 12,000 feet above sea level, and sits in a large valley. Before the integration of its ART system, La Paz was one of the few major cities in the world that did not have a major transit system, other than its existing bus transit. Similar to Medellin, La Paz was made up of densely built, urban neighborhoods, with winding roadways, and crippling traffic that required extremely long commute times. These issues had caused entire communities to become completely disconnected, as neighborhoods were separated from employment centers, schools, and amenities. The greatest disconnection however was between La Paz and the El Alto community, which has seen an enormous population increase and sits above La Paz, on the lip of the plateau. El Alto is generally a poorer and younger neighborhood; and due to the geographic and transportation boundaries between the two neighborhoods, a social, cultural, and economic divide had emerged.<sup>237</sup>

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<sup>237</sup> JACOBS, *Aerial Cable Transit Feasibility Study* (Miami: Miami-Dade Metropolitan Planning Organization, 2016), 34.



community. The transit network has been so successful that a second phase is being planned to extend the route another 12.1 miles with an additional 23 stations.<sup>239</sup>

Constructed in 2014, the new ART system currently connects the downtown area of La Paz with the surrounding communities along the plateau—including El Alto—using three different route alignments: the Red Line, Green Line, and Yellow Line. The Red Line was the first alignment to be constructed; and spanning a total length of 1.5 miles, it saw over two million trips in the first two months of operation. This route connects the plateau community of El Alto to downtown La Paz, and has a commute time of 10 minutes. The Yellow Line was the next route to become operational, connecting the southern end of El Alto—stretching a total of 2.4 miles—to downtown La Paz, with an overall commute time of 13.5 minutes. The Green Line is a 2.3 mile extension of the Yellow Line, and is used to provide connections to the southern communities of La Paz, with a total commute time of 16.5 minutes. Overall, these new route alignments provide a significant reduction in commute times for traveling residents and visitors. Where previous trips took between one and two hours, the commute times are now 10-17 minutes.<sup>240</sup>

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<sup>239</sup> "Bolivia Revolutionizes Urban Mass Transit: From The Streets To The Sky", NACLA, 2016, <http://nacla.org/blog/2014/12/26/bolivia-revolutionizes-urban-mass-transit-streets-sky>.

<sup>240</sup> Ibid.





Figure 38: Mi Teleférico, La Paz, Bolivia. Source: GondolaProject/<sup>241</sup>

Like the Medellín Metrocable, the La Paz system uses MDG technology and can carry 10 passengers at once, traveling at a maximum speed of 11.4 miles per hour. The route alignment uses support towers, approximately 150 feet tall, to traverse longer distances over urban terrain. While performance statistics are still being gathered, the system is heavily used. Since its operation, it was reported that the system has approximately 36,000 daily riders and over 30 million riders annually.<sup>242</sup>

Overall, Mi Teleférico in La Paz, Bolivia was chosen as a precedent study because it again shares some of the challenges and opportunities that Honolulu is currently facing. These include being located in a highly developed urban environment, facing increasing roadway congestion, having major economic opportunities, having public transit used by both residents and visitors, the need to traverse of over private and public buildings, and needing to extend the reach of existing public transit. La Paz's Mi Teleférico strongly shows how a developed city can make social, economic, and development progress by

<sup>241</sup> "Mi Teleférico « The Gondola Project", *Gondolaproject.Com*, 2017, <http://gondolaproject.com/category/installations/mi-teleferico/>.

<sup>242</sup> JACOBS, *Aerial Cable Transit Feasibility Study* (Miami: Miami-Dade Metropolitan Planning Organization, 2016)., 34.

using an alternative transportation system to increase mobility between communities surrounding the urban core.

### 8.3 Caracas, Venezuela – Metrocable

Another area taking advantage of ART's capabilities is the neighborhood of San Agustín, located in the city of Caracas, Venezuela. Similar to Medellín, Caracas is located in a valley, with surrounding residential homes built along the slopes, embracing the downtown area. San Agustín is situated on a ridge next to Avenida Lecuna, and has a resident population of approximately 40,000. The poverty stricken residents in this neighborhood had been separated from the city below by steep topography, highway infrastructure, and a canal, which forced residents to spend several hours per day climbing up and down stairs just to reach their jobs and schools. During the rainy season, many of these paths were even more dangerous as they were easily prone to flooding.<sup>243</sup>

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<sup>243</sup> Michael Contento and Lindsey Sherman, "Metro Cable", *Urban Think Tank*, 2016, <http://u-tt.com/project/metro-cable/>.



Figure 39: Caracas Metrocable Integrating with Existing Transit.

Source: ArchDaily<sup>244</sup>

To address San Augustin's isolation, the government began implementing a plan to construct a new road system and bus lines. Planners and architects realized that entirely new roadways would require demolishing nearly 1/3 of the residential population, uprooting families, and destroying the urban fabric that socially and culturally made San Agustín unique. Instead, architects proposed to introduce an aerial ropeway network that would be less physically destructive and still strengthen the transportation network between San Agustín and the city below. After numerous site surveys, community workshops, and consultations between architects, planners, and consultants, it was determined that constructing ART in these areas would provide the most social and economic opportunities to its residents and visitors. The city ultimately pushed for a design that focused on additional housing, employment opportunities, and commercial activity, as well as cultural, community, and recreational space around each aerial station to benefit residents as much

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<sup>244</sup> "Gallery Of Metro Cable Caracas / Urban-Think Tank - 9", *Archdaily*, 2013, <http://www.archdaily.com/429744/metro-cable-caracas-urban-think-tank/512b0097b3fc4b11a700a96c-metro-cable-caracas-urban-think-tank-photo>.

as possible. Planning began in 2006 and the station became operational in 2010. The system was found to be immediately useful and affordable, as it attracted approximately 1,200 transit riders per hour.<sup>245</sup>

Like the Medellin Metrocable, the system in Caracas was designed to be fully integrated within the existing bus and rail network to maximize access to residents and visitors by supporting a dynamic, multi-modal transportation network. The 3-mile route is comprised of two terminal stations and three intermediate stations, coming to a grand total of \$18 million. The line also uses the same public transit payment system as the bus and rail system for efficient multi-modal transfers.<sup>246</sup>

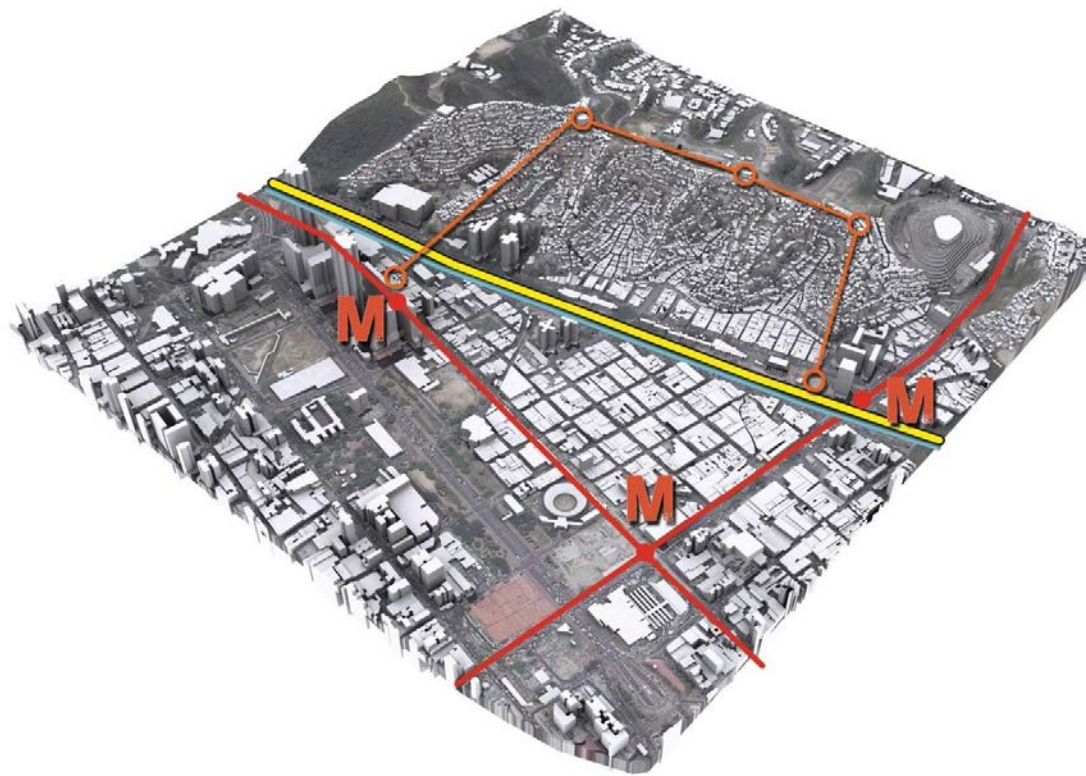


Figure 40: Caracas Metrocable Integrating with Existing Transit. Source: ArchDaily<sup>247</sup>

<sup>245</sup> Ibid.

<sup>246</sup> B. Alshalalfah et al., "Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art," *Journal of Transportation Engineering*, 260.

<sup>247</sup> "Gallery Of Metro Cable Caracas / Urban-Think Tank - 9", *Archdaily*, 2013, <http://www.archdaily.com/429744/metro-cable-caracas-urban-think-tank/512b00c5b3fc4b11a700a973-metro-cable-caracas-urban-think-tank-isometric-metrocable>



Another unique feature of this system was the large turns that were made along the routes. Traditionally, extreme turns are more difficult to construct and are sometimes avoided due to the nature of the system and the potential cost increases. However, the Caracas Metrocable utilized two 90 degree turns to navigate the urban landscape. The turns were designed to not require an additional drive system, which systems with multiple turns usually require. Instead, engineers and designers utilized a single standing, passive bull wheel, which ultimately reduced the complexity, size, and overall cost of the entire system. This exemplifies how the turn station in Honolulu might be constructed, especially in the building-dense areas of Waikīkī where angle turns are required at the Kanekapei and Lilioukalani Avenue stations. This also demonstrates the ability for ART to innovate and improve technology in order to adapt to the surrounding urban landscape.<sup>248</sup>

The Metro Cable in Caracas was chosen as a precedent study because it shares challenges and pursues similar goals to the ART project in Honolulu, including safe access to public transportation for residents and visitors, more economic and development opportunities surrounding the alignment route, sustainable and permanent infrastructure to provide stability to the transportation system, and an improvement in social connectivity between residents living in the downtown areas.

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<sup>248</sup> Michael Contento and Lindsey Sherman, "Metro Cable", *Urban Think Tank*, 2016, <http://utt.com/project/metro-cable/>.

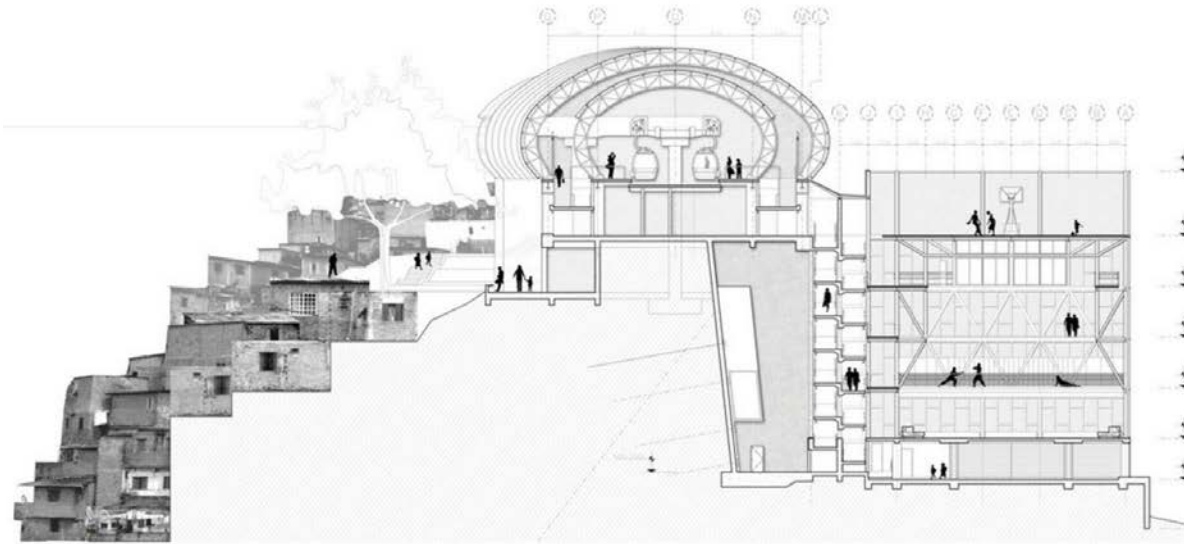


Figure 41: Caracas Metrocable Terminal Station and Attached Community Development.  
Source: ArchDaily<sup>249</sup>

Since its construction, the project has had a large impact on the local communities and continues to circulate residents and visitors to destinations around the city, opening up social and investment opportunities, while serving as an effective model for future urban planning projects. The project has been viewed as a major success thus far, and current plans are already underway to create another Metrocable line in Palo Verde that will connect to the existing metro line and provide more access to surrounding communities and destinations.<sup>250</sup>

<sup>249</sup> "Gallery Of Metro Cable Caracas / Urban-Think Tank - 9", *Archdaily*, 2013, <http://www.archdaily.com/429744/metro-cable-caracas-urban-think-tank>

<sup>250</sup> Ibid.

## 9.0 The Transit Station Interface

While every mode of transportation is unique in its method of movement through various landscapes and geography, nearly every system utilizes stations and/or terminals as points for the transfer of passengers. Buses, airlines, ferries, and streetcars each have nodes along their route where passengers can board the particular mode of transportation, arrive at their destination, and/or transition between systems—ART is no exception.

Studying ART's route throughout Honolulu is imperative in order to understand how the elevated transit system will provide increased mobility and access to both residents and visitors at a much larger scale. It is also necessary to consider how the transit infrastructure will engage the built environment. This chapter helps to lay the foundation for this project's thesis by describing the importance of the transit station within the greater urban context. The following chapter describes transit facility guidelines, it presents various design strategies, and introduces potential opportunities for new growth within station's immediate area—all in an effort to establish a clear-cut vision for the implementation of an aerial ropeway transportation system within the city of Honolulu.

In order to understand how a station should be designed, one must understand the role that a transit station plays within its surrounding community. Since the ART line acts as a driver for social and economic improvement past the Ala Moana rail station, it is exceedingly important that the new station's design run congruent with the community's existing growth principles.

### 9.1 The Role of the Transit Station

As mentioned in previous chapters, one of the fundamental roles of transportation within an urban environment is to shape the social, physical, and economic landscape by providing spatial movement for people to move fluidly throughout the city. As the ART system in its entirety can be perceived as a string, a chain, and/or multiple routes; the stations themselves act as the links that connect these routes together. Aside from the route pathway itself, the station locations are strategically placed in order to provide the maximum amount of both access and opportunity possible.

These transit stations provide access points for passengers to not only be able to enjoy the experience of traveling, but also to allow them to arrive at their chosen destination. Though the transit station is, in the simplest of form, a link providing passengers access from one mode of transportation back to the street, the ART station must be designed to possess a number of other, less obvious, functions that positively affect a community's socio-economic wellbeing.

### *The Station as an Urban Gateway and Landmark*

A gateway is defined as, “a place that provides access to another place,” or “a means of achieving a state or condition.”<sup>251</sup> One important, experiential aspect of the transit station, setting it apart from other buildings within a city, is its unique function to act as a gateway or landmark. Transit stations, unlike many other buildings, are not stand-alone structures. Linked by circulating networks, these stations are considered places that are intermediary along an individual's overall journey; but most often, they do not represent a final destination. For example, shopping centers, museums, and/or office buildings are all elements of the urban fabric that individuals travel to with an intention of spending longer durations of time at. When visiting one of these destinations, the individual is typically moving at a slower pace, casually engaged with the experience of that particular place. In contrast, transit stations are buildings in which people travel through, and are only experienced briefly in travel. While larger stations can offer similar leisure experiences—such as integrated shops and restaurants—the sole type of movement within the station is one of hurried directness, as people usually have a location to travel to beyond the location of the station. Additionally, its unique function within the city directs public awareness towards its presence.<sup>252</sup> In this sense, the station's primary function as a transition point, as well as its visual presence, act as a gateway for both transit riders and the surrounding community, thus helping to establish a defining point in the town center. Furthermore, this theory of the station being both a physical and visual gateway, highlights the importance

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<sup>251</sup> "Gateway", *Oxford Dictionaries | English*, <https://en.oxforddictionaries.com/definition/gateway>.

<sup>252</sup> Brian Edwards, *The modern station: new approaches to railway architecture* (New York, NY: Taylor & Francis, 1997), 761.



of its functional performance as well as the potential for a higher quality of design within the city.

### *The Station as a Place-maker*

History has shown that successful transit stations are buildings that improve the quality of life for both residents and visitors, while simultaneously instilling pride and strengthening a neighborhood's sense of place. Additionally, a transit station holds high potential to provide substantial benefits to a community since it is a public building utilized by thousands of individuals visiting from both near and far. Though it is fundamentally a transition point between two destinations, the station itself should still be recognized as place worthy of quality design because of its potential to substantially benefit the nearby community. And so, most importantly, the station should be a place where people enjoy returning to.<sup>253</sup>

One strategy for ensuring this is to design the station as a focal point. In neighborhoods and areas that lack nearby amenities, character, and/or visual quality, integrating stations with dramatic or distinct architectural design qualities can help to establish the station as something unique or valuable to the community.

Another way to improve the community value of the station is to integrate high-quality gathering spaces in and around the facility for people spend longer periods of time. Depending on size and scale, transportation stations can be great places for people to meet others, spend leisure time, or even get some work done. Therefore, providing spaces to accommodate these activities can potentially improve that community's perception of the station and attract new transit users to the system. Gathering space types can include plazas with seating areas and tables, vegetated and landscaped parklets, recreational space, or any multi-programmable gathering spaces that serve the varying needs of the community.

Another important characteristic that can improve its community value is designing the station to be a noticeably safe environment. A transit station that provides riders a safe and welcoming environment will help to ensure that people continue using the particular mode of transportation that the station houses. Several tactics that improve rider safety

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<sup>253</sup> Parsons Brinkerhoff and Placemaking Group, *Honolulu High Capacity Transit Project: Urban Design Guidelines*, report, Final Draft (Honolulu, HI : City and County of Honolulu, 2009), 34.

include providing proper lighting, activating spaces, improving sightlines and visibility, ensuring sufficient egress and intuitive circulation paths, and providing a clean and well maintained facility.

### *The Station as an Expression of Sustainability*

One reason ART is offered as an alternative solution to other public transit systems is because it is more energy efficient, produces less atmospheric emissions, and is a shared form of transportation. With vehicular transportation being one of the leading causes of atmosphere pollution, ART would be positive step toward pollution mitigation. And yet another important way to demonstrate a station's value within the community, is to design the station in a way that expresses sustainability. With rising interest in preventing climate change along with ensuring that Hawai'i become an energy independent state, having a transit system that reflects the communities' environmental sustainability principles will help to ensure the transit system's success in the future.

Important strategies for promoting the station as green transit, is to ensure that the station also incorporates energy efficient, waste reduction strategies. These can include designing for natural lighting and ventilation to help create a comfortable and healthy station environment; while more visible sustainability strategies can include landscaping such as green roofs, parklets, bioswales, and incorporating the use of more sustainable construction materials. In addition, educational strategies can include signage and/or plaques that describe the aerial ropeway station as a sustainable transit structure.<sup>254</sup>

### *The Station as an Economic Attractor*

One of the most important functions that a transit station serves is that of being an economic magnet. Because the station is a focused area where large volumes of people must gather in order to board the transit system, those larger groups of people tend to also have an economic influence within the immediate and surrounding area. Large influxes of people increase the flow of capital, which only further draws in the attention of businesses, residences, and government centers wanting to establish themselves nearby. Utilized by an extremely diverse mix of individuals—either traveling for work, for leisure, or for school—

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<sup>254</sup> Ibid.,40.

transit stations are especially effective at establishing new development centers, and in many instances leading to massive urban development projects that can potentially provide immense growth to both new and existing towns and cities.

On Oahu, for instance, many economic and neighborhood centers have grown outward not only along transit routes themselves, but also focused around the transit stations or hubs. For example, Honolulu–Hawai‘i’s state capital and economic center—emerged around Honolulu Harbor, which served as the island’s primary port of entry during the 19<sup>th</sup> century. During this time, the whaling industry, followed by an agricultural boom, drew immigrants and residents into the area, spurring industry growth and development. Nearby transportation links also helped to establish Waikīkī as another of Oahu’s major economic nodes. With the development and expansion of Honolulu, new streetcar routes greatly increased accessibility into Waikīkī. Known for its geographic beauty and pristine beaches, the increased access to Waikīkī via public transit routes helped to increase activity and investment within the area, ultimately giving rise to what is now Hawai‘i’s main tourism center.<sup>255</sup>

As mentioned in previous chapters, it is imperative to understand how station locations have the potential to greatly influence the immediate and surrounding urban landscape both economically and socially. And furthermore, that careful consideration of the site, the people, and the place, as well as their relationships among one another, need to be undoubtedly understood before integration and construction can begin.

### *The Station as a Bridge*

Transportation pathways, such as ground level railway lines and vehicular roadways, often act as boundaries and dividers within the urban landscape. Over time, roadways, highways, and railway infrastructure have proven to be physical dividers that can divide neighborhoods, towns, and cities, consequently limiting a community’s social well-being and economic potential. However, typical methods that allow people to cross infrastructure boundaries often include bridges, tunnels, or crosswalks; and the station

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<sup>255</sup> Kristen Pederson, "Honolulu Harbor's Historic Beginnings", *Historic Hawaii Foundation*, 2016, <http://historichawaii.org/2016/06/28/honoluluharbor/>.

itself, can be designed as an access point, or bridge, to provide stronger connectivity and access within the immediate community. For example, pedestrian boarding platforms can be designed to incorporate a bridge, which would then allow people to cross freely over the station's own infrastructure path. Other design strategies can include using the station's roof as a public gathering space, plaza, or park, in an effort to draw people to the station bridge instead of them just quickly passing over it. Overall, the station's secondary ability to provide bridge-like access over dividing boundaries allows it to even further act as a positive public asset within the urban fabric.

One example of the ART station providing such an opportunity, is the Kalaimoku Station on the route alignment 01. As described in the previous chapter, the Ala Wai Canal presents a major man-made boundary that physically divides Waikīkī from the surrounding neighborhoods. The most notable disconnection was determined to be between Waikīkī to UH Mānoa. A station along the Ala Wai Canal, where Kalaimoku Street intersects Ala Wai Boulevard, provides the opportunity to construct a bridge spanning across the canal. Since the proposed station partially sits over the Ala Wai Canal, the structure would be supported by pylons providing an opportunity to build a pedestrian and bicycle platform that could extend across canal.



Figure 42: Kalaimoku Bridge  
Station Source: Made by Author

## 9.2 ART Station Types

The scale and complexity of an ART transit station can vary greatly based on the site's context as well as the community's needs; however, these stations function primarily as either mid-stations or terminal stations. As mentioned in previous research, a terminal station anchors each end of a route alignment, so a route must have at least two terminal stations. Mid-stations are intermediary stations along the route, and are commonly located at strategic locations—community centers and/or neighborhoods—where passengers can either board or alight the system. Another reason for a mid-station's placement occurs when a route alignment is required to make a substantial angle adjustment; as turning equipment is usually needed. And, due to the fact that this sizable equipment can require a larger ground footprint, it is common for turning junctures to also function as mid-stations.

Depending on the surrounding site characteristics, a station will either have an

elevated stop, or a surface stop. As the name implies, an elevated stop consists of a guideway that is situated high above ground level. Its heightened position is most likely due to adjacent obstacles blocking the path of route cable, thus requiring a higher guideway so that the suspended cabins can keep clear of their path. Depending on the height of the guideway, there will need to be substantial vertical circulation within the elevated station so that pedestrians can access the platform from ground level. In comparison, surface stops are stations that are able to place their boarding platform at ground level, and thus do not require larger vertical circulation elements—reducing both the station’s visual profile as well as its cost. Between the two, elevated stops have the potential to be much larger than surface stops; and because of their size, they tend to be constructed over roadways and intersections; while surface stops will generally have less existing, surrounding obstructions.

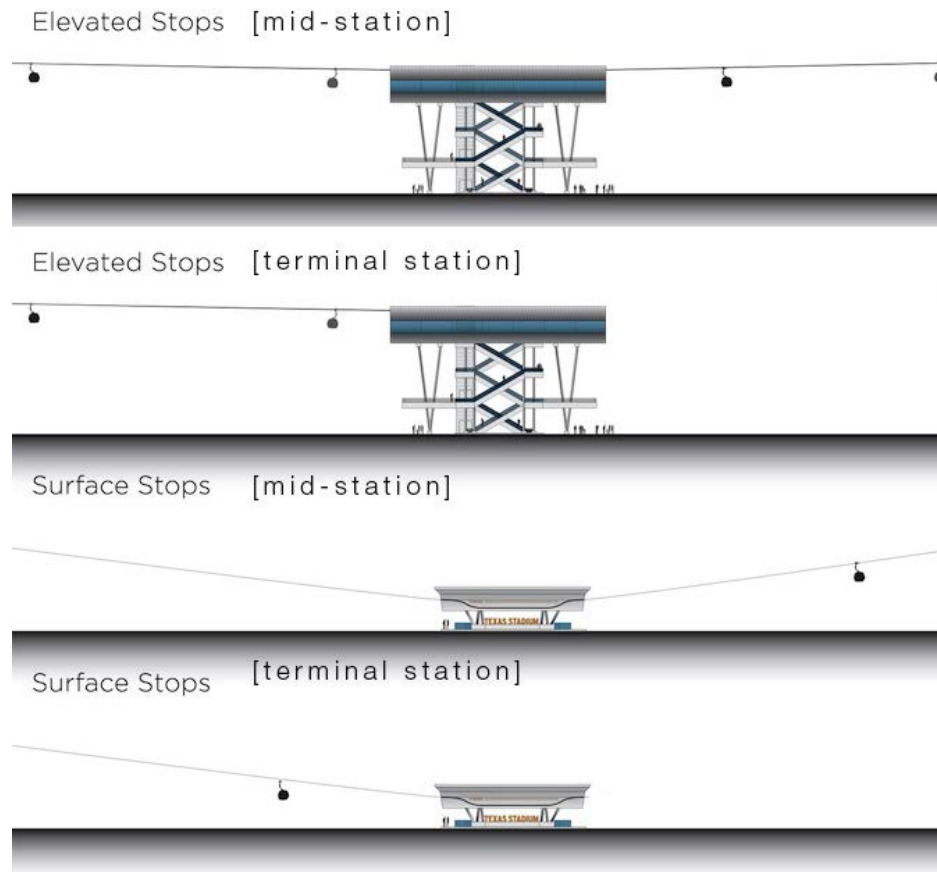


Figure 43: ART Station Types

Source: Frog Design<sup>256</sup>

Illustration: Edited by Author

<sup>256</sup> Lamar Anderson, "Keep Austin Wired! A "Wire" Of Aerial Gondolas Would Turn Pedestrians Into Skywalkers," Architizer, November 29, 2012, , accessed February 27, 2017, <http://architizer.com/blog/austin-aerial-gondolas/>.

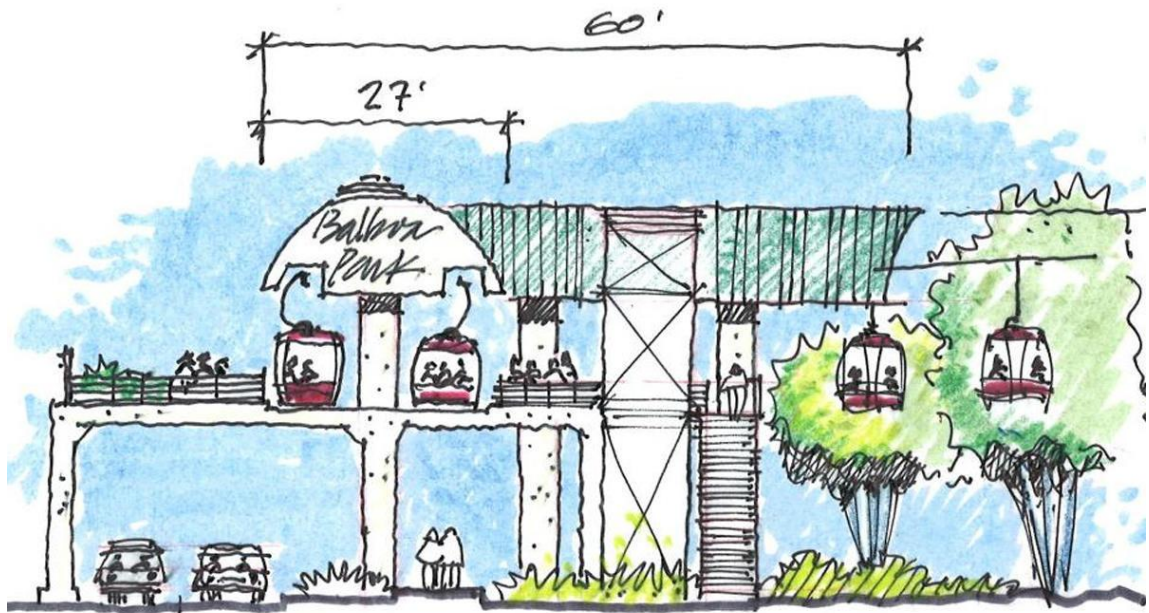


Figure 44: Elevated Station Section Sketch

Source: sandiegoite.org<sup>257</sup>

### 9.3 Elements to Consider

#### *Station Zones*

Layout of a station can be challenging due to the number of different elements that need to be integrated. However, to help spatially organize the space functions, the parts can be primarily simplified into the core, peripheral, and circulation areas.<sup>258</sup> The core, which can be defined using architectural elements, is the heart of the station, otherwise known as the the area which users identify as being the center. The core is where complex functions such as ticketing, information, and amenities occur, and it is usually directly connected to the main station entrance. Peripheral areas, comprised of the spaces where station patrons transition to and from the core, primarily include the boarding platform, restrooms, and back-of-house spaces. However, depending on the size of station, the core can be also be

<sup>257</sup> Urban Aerial Ropeway, ebook, 1st ed. (San Diego: ITE, Sandag, Parsons Brinkerhoff, 2017), 16, <http://www.sandiegoite.org/wp-content/uploads/2012/08/WSP-PB-Urban-Aerial-Ropeway.pdf>.

<sup>258</sup> Brian Edwards, *The Modern Station: New Approaches To Railway Architecture*, e-book, (London: E & FN Spon, 1997).



small, only consisting of information and ticketing functions. Lastly, circulation—what connects all of these spaces together—typically is inclusive of egress stairwells, walkways, and elevated bridges. Without clear and defined circulation between the core and peripheral areas, the station function quickly falls apart.

### *Circulation*

Circulation throughout the ART transit station is an important consideration because it is the key aspect to designing the station's overall design and layout. In terms of exterior circulation, it should be clear as to where the pathways in and out of the station are located. This means that it must be clearly visible as to where the main entrance of the building is, as well as to where other points of access and egress lead to around the property. Transit riders arrive at and leave the station using a number of different transportation types. Therefore, clearly defined pathways to and from waiting areas, bus stops, and vehicle pedestrian drop-off zones should be at a comfortable width, clearly marked, and properly lit to help the user navigate to the inside of the building as easily and as quickly as possible. Architectural elements such as overhangs and/or canopies, placed over major entry and transition points, can help to guide users around the station, while simultaneously providing the station with visual interest.

Once inside the station, the user needs to be able to quickly and easily find his/her way from the ticketing area to the boarding platform without stress, frustration, and/or the fear of getting lost. The transit rider demographic is also incredibly diverse, which means the station will be filled with different people, walking at different speeds and in different directions. Some users may be in a hurry to drop their children off at school before going to work, while others may want to explore the newsstand and have a coffee before heading to the beach. Because of this, it is important to make sure that paths have a hierarchical quality to them, with the clearest and most direct paths leading to and from the boarding platform. Overall, circulation inside and outside should be clear, well lit, and have direct lines of sight in order to maximize ease, comfort, and safety when using the station.

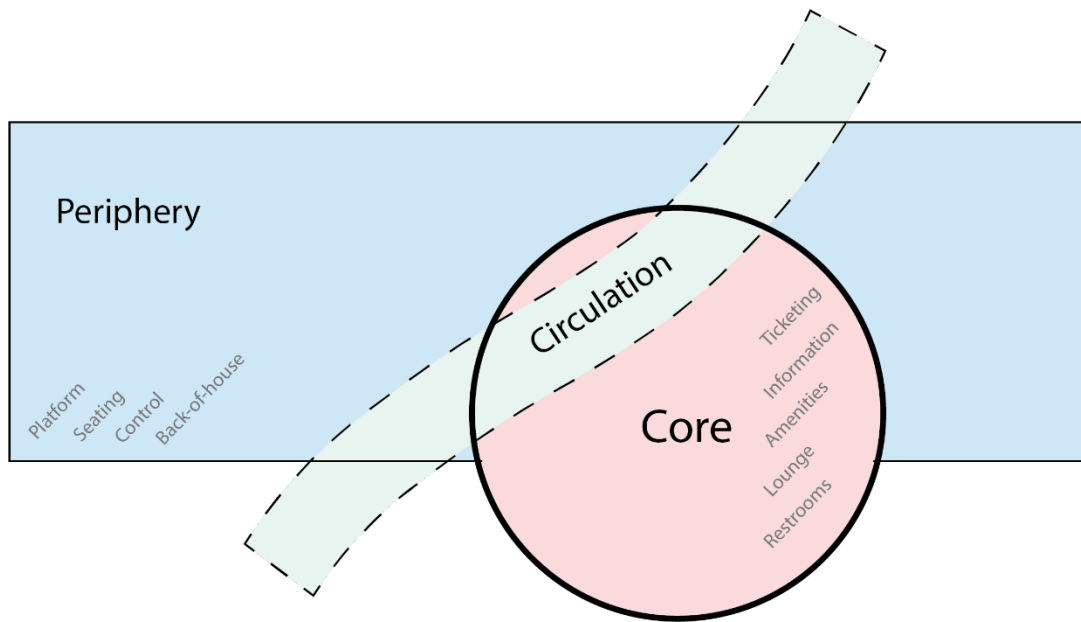


Figure 45: Station Zones

Source: Brian Edwards<sup>259</sup>

Illustration: Made by Author

#### *Community Connectivity and Access*

One of the most important aspects regarding a transit station's successful integration into a community, aside from the station's actual site location itself, is its ability to provide intermodal connectivity between transportation systems. It must be recognized that fluid movement through a city does not rely on the capacity or speed of a single mode of transportation, but on the careful balance between numerous transportation types and how well each network interconnects with each other and the surrounding landscape. As most individuals will opt for the mode of transportation that is fastest, most cost effective, and most comfortable, it is important that transitioning from one system to another be as seamless and convenient as possible.

It is unrealistic to predict that a new transit system will fully transition residents from one mode to another; therefore, a successful transit station is one that will provide facilities for passengers to step off of one form of transportation and easily walk to another.

<sup>259</sup> Brian Edwards, *The Modern Station: New Approaches To Railway Architecture*, e-book, (London: E & FN Spon, 1997).

The most successful stations, measured by high ridership numbers, encourage other modes of transportation by connectivity features that ease the transition<sup>260</sup>

In Honolulu, for instance, public transportation is solely provided by TheBus, while private vehicular transportation makes up the majority of trips between destinations. As the rail project will be completed in the upcoming years, transit stations have been designed to incorporate features that ease the transition between buses, cars, bicycling, and pedestrians. Encouraging other forms of transportation as supplemental to rail transit will be integral to the system's long-term success, especially as the city invests in new bicycling and pedestrian infrastructure.

Ideally each station should provide all interconnectivity design features; however, depending on the existing characteristics of each neighborhood—such as density, demographics, nearby amenities, and transportation infrastructure—some stations will require greater interconnectivity than others. As described in the Chapter One, the pedestrian holds the highest priority in the transportation hierarchy pyramid. This means every design decision must be made with the priority of creating the highest quality pedestrian space. Therefore, when space is limited, these features will focus primarily on improving pedestrian, bicyclist, and transit user needs first and foremost.

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<sup>260</sup> Geophrey Mbatta, Thobias Sando, and Ren Moses, "Developing Transit Station Design Criteria with a Focus on Intermodal Connectivity," *Journal of the Transportation Research Forum* 47, no. 3 (2012): 78, accessed February 16, 2017, doi:10.5399/osu/jtrf.47.3.2121.

The following section outlines the different design strategies that ART transit stations will implement in order to provide a seamless transition between other modes of transportation:

### *Pedestrian Arrival*

Urban movement by means of walking supports the entire public transit network as it is required when using every and any mode of transportation. People walk to their cars, bus stops, rail stations, etc. at the beginning and end of each trip. Furthermore, walking supports a vibrant community both socially and economically, which is why it is vital, and typically required, that high quality accessibility features be incorporated into all types of transportation oriented design.

Pedestrian features include:

- Wide and clear walkways
- Visible and efficient points of egress.
- Intuitive pathways with direct circulation routes
- Wayfinding strategies

### *Bicyclists*

Bicycling is an especially important part of a successful transit network because it extends the reach of the transit system, while also being most effective in addressing the “last-mile” problem. While comfortable pedestrian walking distances span up to 0.5 miles, bicyclists are found to be willing to travel up to 3 miles to a destination—even further substantiating the notion that adequate bicycling infrastructure is imperative to supporting a successful transit station. Features that support bicycle usage include:<sup>261</sup>

- Safe, secure, temporary, outdoor bicycle parking.
- Safe, secure, temporary, indoor bicycle parking.
- Long-term bicycle storage.

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<sup>261</sup> Nelson Nygaard, Lee Sichter LLC, and VIA. *Kaka’ako Community Development District: TOD Overlay Plan*, report, Final Draft. (Honolulu, HI : Hawaii Community Development Authority, 2016). 5-81.

- Provide space for bicycle sharing programs.
- Design space for bicyclists to bring their bicycles on the gondola cabins.

### *Bus Transfers*

Buses are an integral part of the transit network, especially in Hawai'i. Strategies for maximizing bus connectivity include: <sup>262</sup>

- Having bus stops located within, or as close to the station as possible in order to the main entrance of the transit station.
- Provide adequate seating with shading elements to improve comfort while passengers wait for the incoming buses.
- Create safe waiting environments that are well-lit, and highly visible.
- Provide sufficient space for buses to enter and exit the transit station facility for passenger pick-ups and drop-offs.

### *Vehicle Pedestrian Drop-Off*

Individuals are often dropped off or picked-up at the transit station by a vehicle before or after riding the transit system. This is common for people who use carpools or taxis. Without proper space for this to occur, vehicles will often pick-up and/or drop-off passengers in areas that can slow traffic and create unsafe circumstances for both cars and pedestrians. In order for these scenarios to happen seamlessly, facilities that allow for safe areas, with the sole purpose of being used for dropping passengers off and/or picking passengers up, must be provided. These include:

- Designated Kiss-and-Ride areas located as close as possible to the station entrance.
- Drop-off areas that do not conflict with bus transit stops. Ensure that is located as close to the station entrance as possible.
- Sufficient driveway widths for quick vehicle entry and exit.
- Safe, visible, and well-lit drop-off areas. <sup>263</sup>

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<sup>262</sup> Ibid.

<sup>263</sup> Ibid.

### *Vehicle Accessibility*

Though private automobile use remains at the bottom of the transportation hierarchy, it is inevitable that some residents may need to occasionally park their car in or around the station before using public transit. While most stations will aim to limit the amount of on-site parking, or even eliminate it completely, some community stations may choose to integrate it into the station. Strategies for improving vehicular accessibility include:<sup>264</sup>

- Park-and-Ride Facilities
- On-site parking spaces, preferably underground to reduce open parking spaces surrounding the station.
- Efficient entry and exit locations that do not conflict with bus or rail transit transfer points.
- Zip-Car

Overall, the ART is a unique, yet familiar transportation interface. While its main function is to act as a place for the transference of passengers between the city and a mode of transit, it has so much more to offer beyond a simple moment in passing. The ART station has a unique and identifiable presence in the city; and even furthermore, as a public building, it has the potential to benefit the community beyond what is seen at the surface. Based on this exploration of the different roles, as well as some of the fundamental features that are required for an efficient station, a conceptual and basic station will be designed to help visualize how this system might successfully mesh with the existing urban fabric.

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<sup>264</sup> Ibid.

## 10.0 Station Design

Integrating ART into an urban environment is a major decision that can fundamentally change how residents and visitors circulate through a city. Because the use of ropeway in major cities is a relatively new concept in American, the construction of an ART system within a community along with its resulting advantages can be difficult to envision. And, it is for this reason that this chapter aims to present a conceptual station design for ART in Honolulu—visually expressing how the station would physically engage with the city. The ART station operates as the human interface for the entire system, which is why the design will focus on how the station can act as a catalyst for change by supporting social and economic opportunities while maximizing pedestrian and transportation accessibility.

In Chapter Seven, several ART route pathways that could potentially run through the city of Honolulu are closely scrutinized. And after careful consideration, Route Alignment 01 was chosen as the proposed path, as it was determined to be capable of providing the most benefits in terms of accessibility between neighborhoods. While this alignment has several terminal and mid-station points, a single station site was chosen to be designed in order to provide a visual example of how an ART station could be implemented within Honolulu.

### 10.1 Site Analysis

The chosen station on this route is the “Hawai‘i Convention Center Station,” or station number two. This site is located mauka from Hawai‘i Convention Center on the corner of Kalakaua Avenue and Kapi‘olani Boulevard. This mid-station was selected because of the significance of its location as a gateway juncture between the Ala Moana, Moilili, and Waikīkī neighborhoods, as well as the potential social and economic opportunity the ART system could bring into the immediate community. As seen in the figure below, the site location is just outside of Waikīkī and in close proximity to the Ala Moana Shopping Center, along the Kapi‘olani Boulevard corridor.

One important characteristic of the site is its close proximity to nearby community assets including Waikīkī, Ala Moana Shopping Center, and the Hawai‘i Convention Center. City-funded studies including the *Ala Moana Transit Oriented Development Plan* and the *Complete Streets Project Study* identified this area as an opportunity for improvement because it is considered by the community to be the gateway into Waikīkī. This prominent site, located at one of the most active intersections along Kapi‘olani Boulevard, and in conjunction with the presence of the Hawai‘i Convention Center, acts as a visual landmark for people entering and exiting Waikīkī. However, being an urban gateway suggests the location should provide a memorable point of passage from one space to the other by reflecting the significance of the area that it is providing passage to. As mentioned in Chapter Nine, an urban gateway should also create a strong sense of community pride and act as a symbol for a place that both residents and visitors are eager to return to. Unfortunately, today this perceived gateway provides the community little value beyond being a massive vehicular intersection.



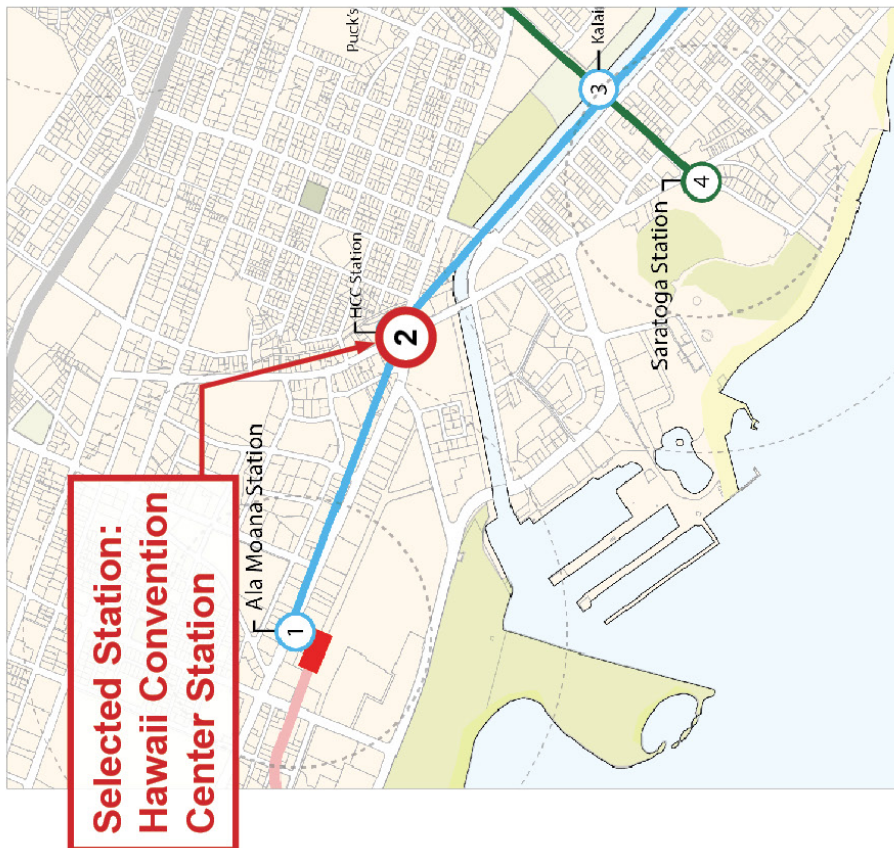


Figure 46. Selected Station for Conceptual Design  
Source: Made By Author

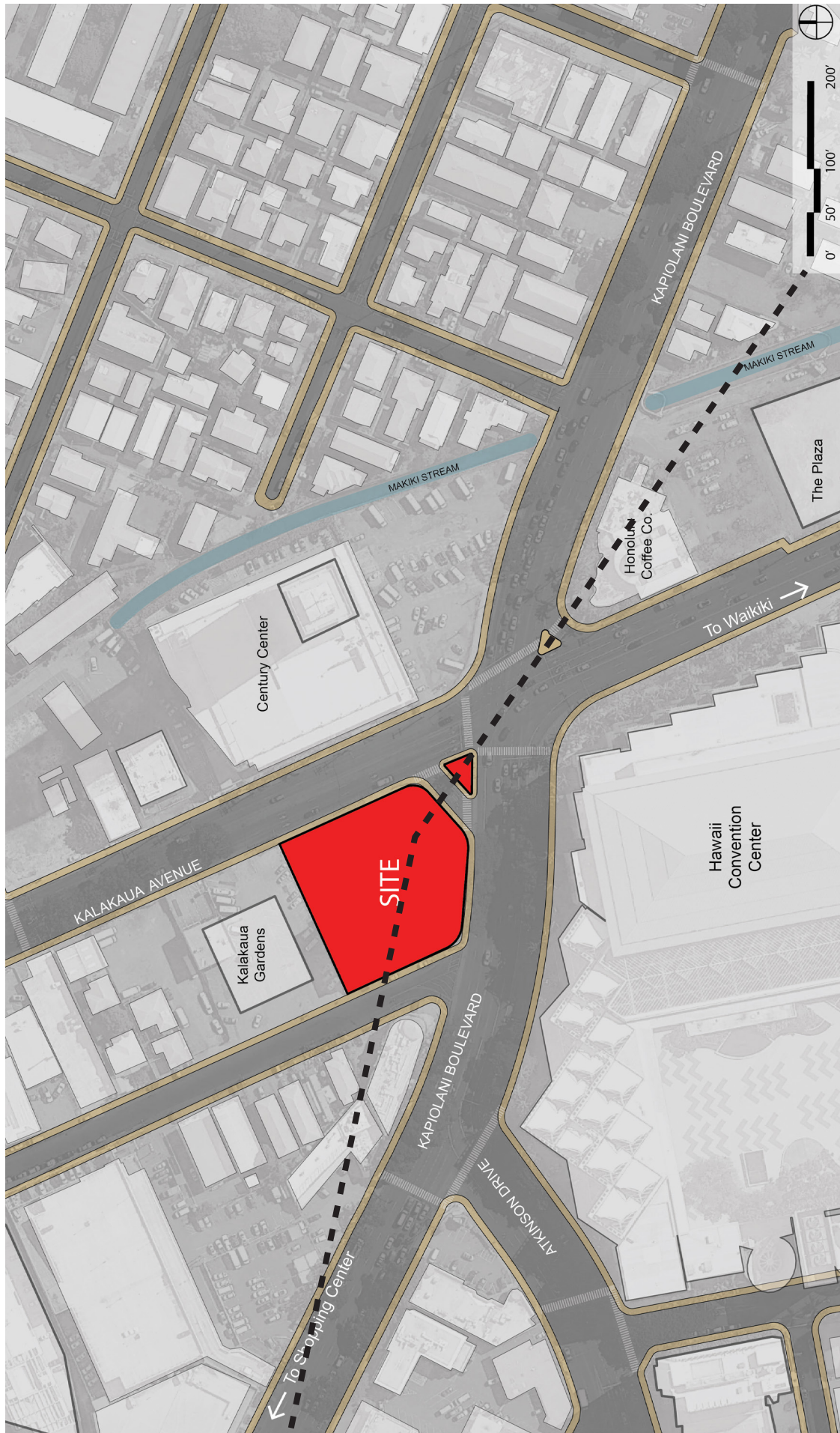




Figure 47: Site Location and Zoning Districts

Source: Made by Author





--- ART Pathway

Figure 48: Site Location  
Source: Made by Author



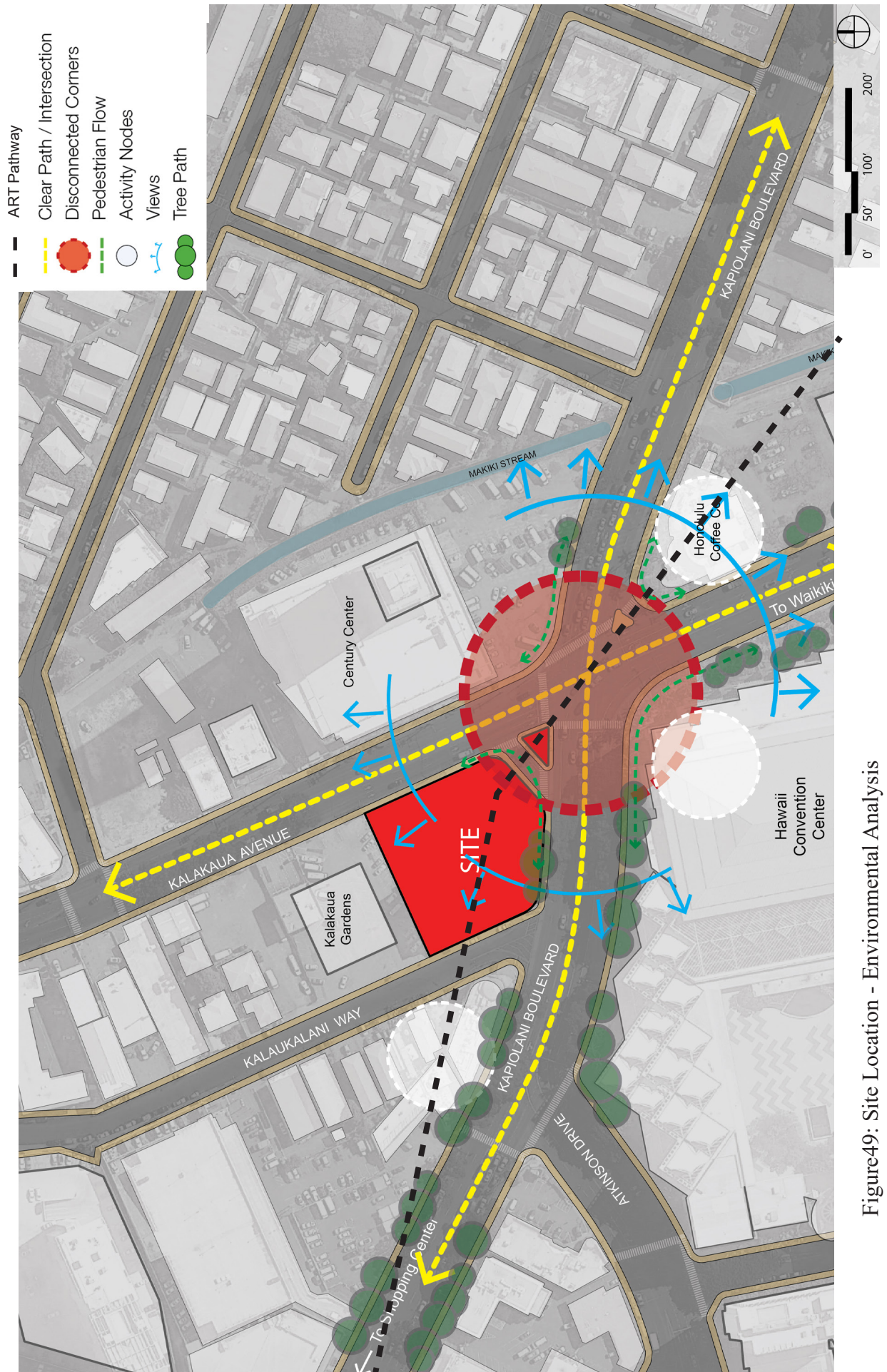


Figure49: Site Location - Environmental Analysis  
Source: Made by Author



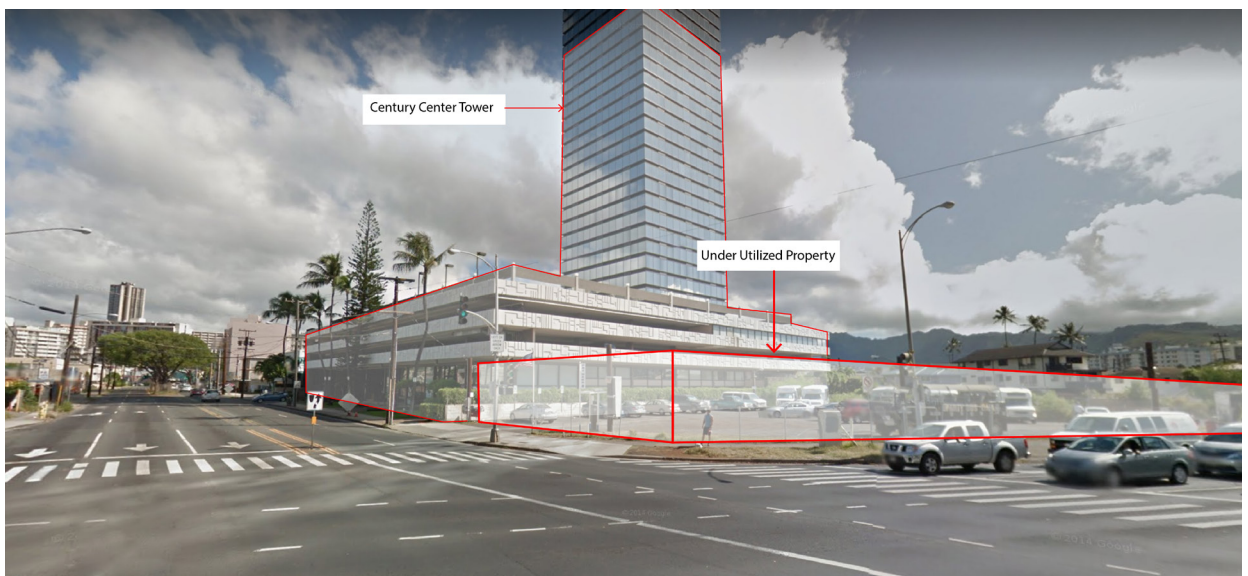


Figure 50: Site Images  
Source: Google Images  
Illustration: Made by Author



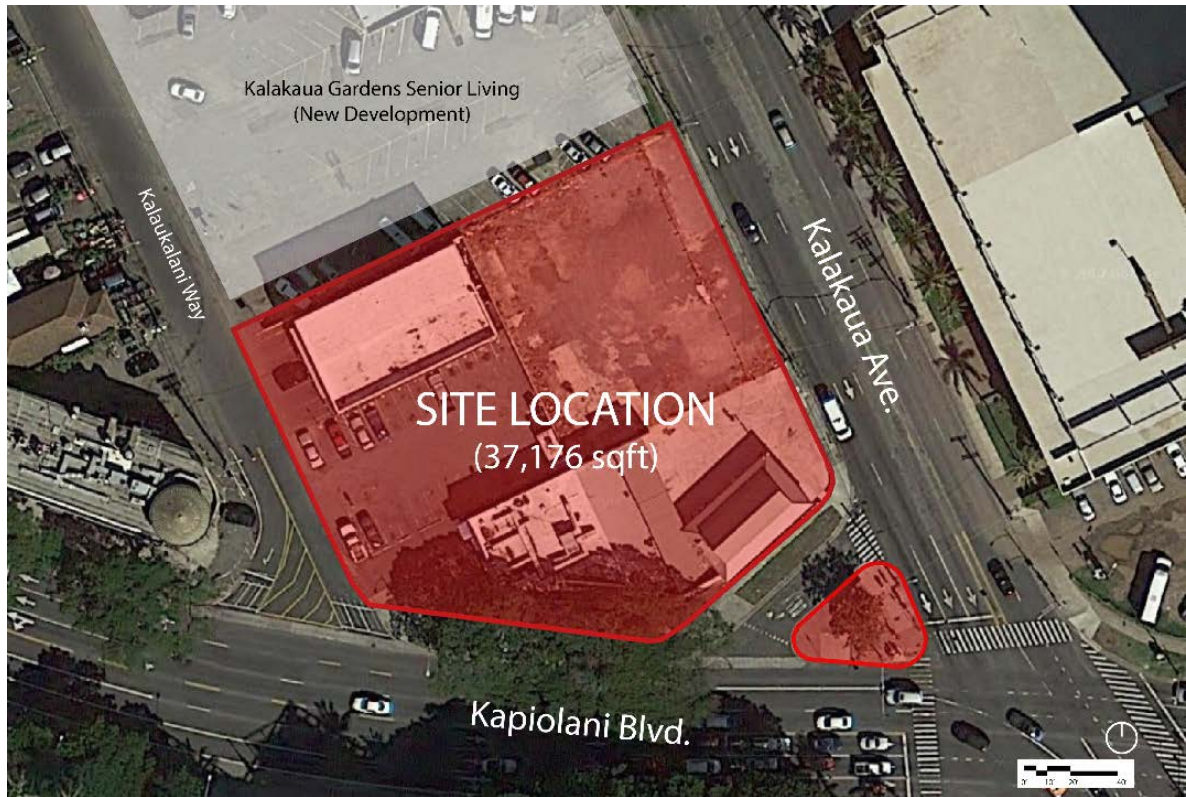


Figure 51: Site Location  
Source: Google Earth Satellite View  
Illustration: Made by Author

### *Existing Properties*

Excluding the Hawai‘i Convention Center, the properties located on each corner of this intersection do not support a lively area because they are hugely underutilized. The station site location—situated on the North West block—is currently home to Micronesia Mart, a small specialty market, and Rock-Za!, a decrepit gentlemen’s club. Though these buildings have existed for a number of years on this property, their functions do not adequately improve the community’s overall quality of life or reinforce the need for a more lively, public space. For example, Rock-Za! Gentlemen’s Club is perceived by neighborhood residents and nearby businesses to be a negative community business operation that many are eager to see leave.

The next property, located at 1810 and 1830 Kapi‘olani Boulevard—on the north east corner of the intersection, adjacent to the Century Center mixed-use tower—is an undeveloped property currently used as a paid parking lot by District Parking Services.

Visually, the property is an eyesore; especially since it is surrounded by chain-link fencing and unkempt landscaping.

The next corner site, located at 1800 Kalakaua Avenue—directly across the street, on the southeast block—is home to the newly renovated Honolulu Coffee Experience Center. Originally the site of the old Hard Rock Café, this 41,000 square foot property, owned by Aloha Securities & INV Co., is home to a large coffee roaster. Though the property provides a pleasant café and restaurant environment, this single function does not provide enough pedestrian traffic to support a lively community; primarily because half of the nearly one-acre property is used as a parking lot for commercial vehicle storage.

Overall, while these site locations are extremely prominent, the properties situated atop each site do not provide enough community value—visually, socially, or economically—and in turn, do not support this location as being an authentic gateway to and from Waikīkī.

### *Future Development*

However, this area has also been the focus of new development, as many landowners recognize the high value of these properties as well as their potential for growth; especially with the new rail project coming to fruition at the Ala Moana Center. Recent nearby development includes the *Kalakaua Gardens*, a 17-story senior living high-rise that opened in 2016, located just behind the station site; *The Plaza Waikīkī*, an 8-story senior housing center with a total of 150 units, that opened in 2014, located just south of the Honolulu Coffee Experience at 1812 Kalakaua Avenue; and, *The Mandarin Oriental*, though still in its final stages of planning, it stands to be the future site of a 36-story, 400-foot tall, mixed-use tower, located at the corner of Kapi‘olani and Atkinson Drive at 1695 Kapi‘olani Boulevard. In fact, *The Mandarin Oriental* is the first new transit oriented development approved project and will include luxury hotel rooms, residential condominiums, restaurants, and retail space. The project will also include features that promote a lively pedestrian ground floor such as retail and dining locations.<sup>265</sup> Altogether, these new developments have the potential to further support the demand needed to sustain

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<sup>265</sup> Gail Kalinoski, "\$700M Honolulu Mixed-Use Project Receives Green Light," *Commercial Property Executive*, October 12, 2016, accessed February 24, 2017, <https://www.cpexecutive.com/post/700m-honolulu-mixed-use-project-receives-green-light/>.



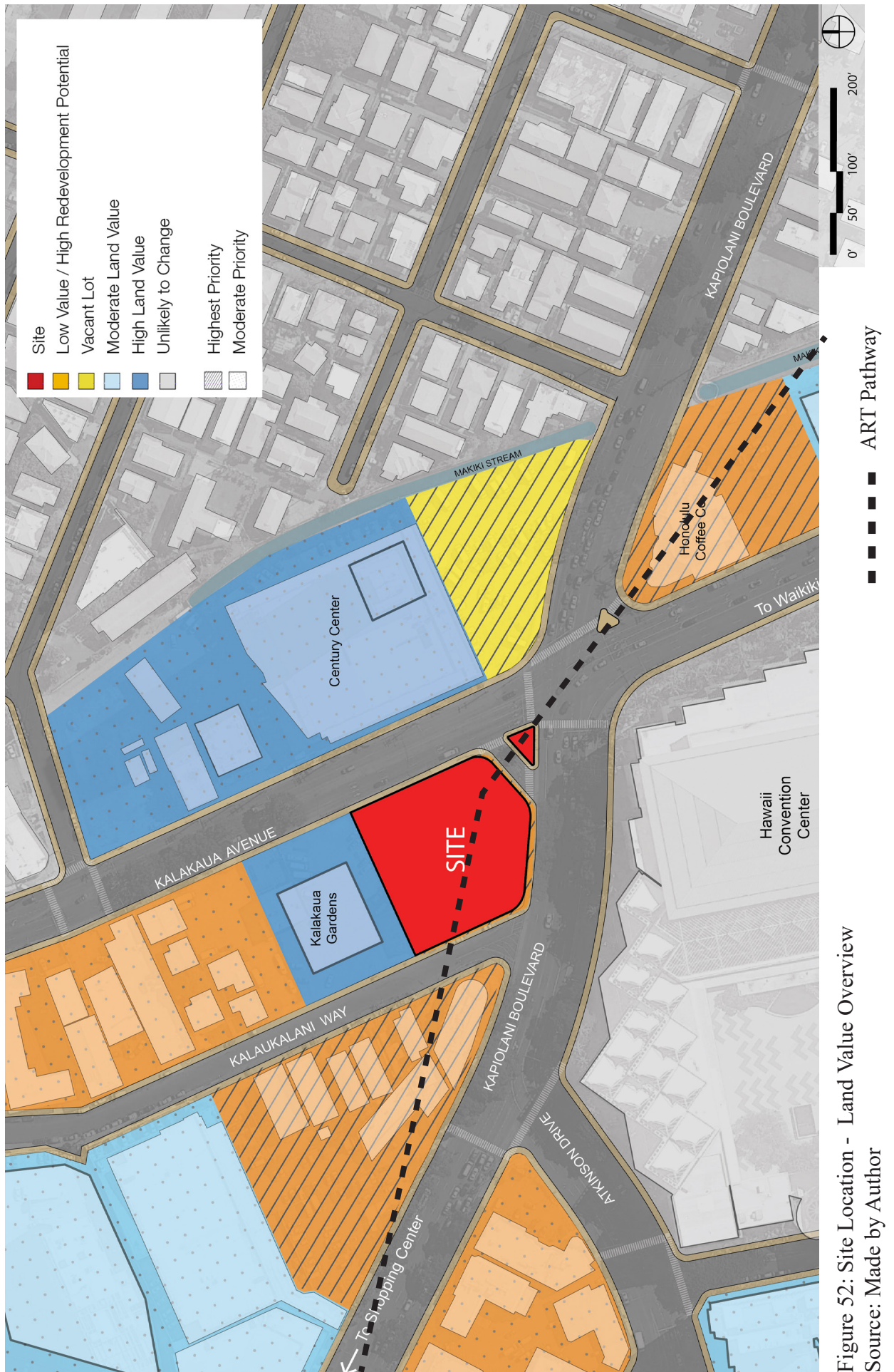


Figure 52: Site Location - Land Value Overview  
Source: Made by Author



a new transit system, especially as they are located within the immediate walking distance of the proposed ART station.

While there are no immediate plans for a high-rise on the site location, or its adjacent blocks, the area is known to be underdeveloped. And, with growing interest among property owners and developers to construct new buildings on these properties—especially with the improving economy—these lots are not likely to remain undeveloped for very long.

Furthermore, Kapi‘olani Boulevard has already been identified as an important corridor for revitalization with several urban blocks assigned a development priority rating based on their potential for socio-economic improvement. The properties located on each block at this gateway intersection, excluding the Hawai‘i Convention Center, were each given the highest levels of priority for redevelopment.<sup>266</sup> Potential community ideas have called for new mixed-use high-rises that would complement Oahu’s new TOD strategy: incorporating a mixture of hotel, residential, retail, and restaurant spaces. Taking into consideration both new and potential future developments, along with the existing residential units of the Century Center and the surrounding neighborhoods, this corner is expected to experience an increase in pedestrian activity.

Though a thorough analysis of the physical environment is imperative when planning any sort of structure, it is also important to understand the site’s target market. As seen in the figure below, the site is unique because it lies at the convergence of the residential and commercial zoning areas between Ala Moana, Moilili, and Waikīkī. The area currently sees a high number of residents traveling to and from work, as well as residents and visitors traveling to the and from the area’s nearby amenities—including the Ala Moana Shopping Center, located only a quarter-mile west of the site. Due to the mixed demographic characteristics, the area has a high number of demands and desires that are needed in order to satisfy the largely diverse number of people living, working, and/or spending leisurely time in the area. This can prove to be especially challenging when designing a new project; having to take into account the entire community’s input. Therefore, this project design will be required to address the basic needs of both the

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<sup>266</sup> City and County of Honolulu, Ala Moana Neighborhood Transit-Oriented Development Plan, 23

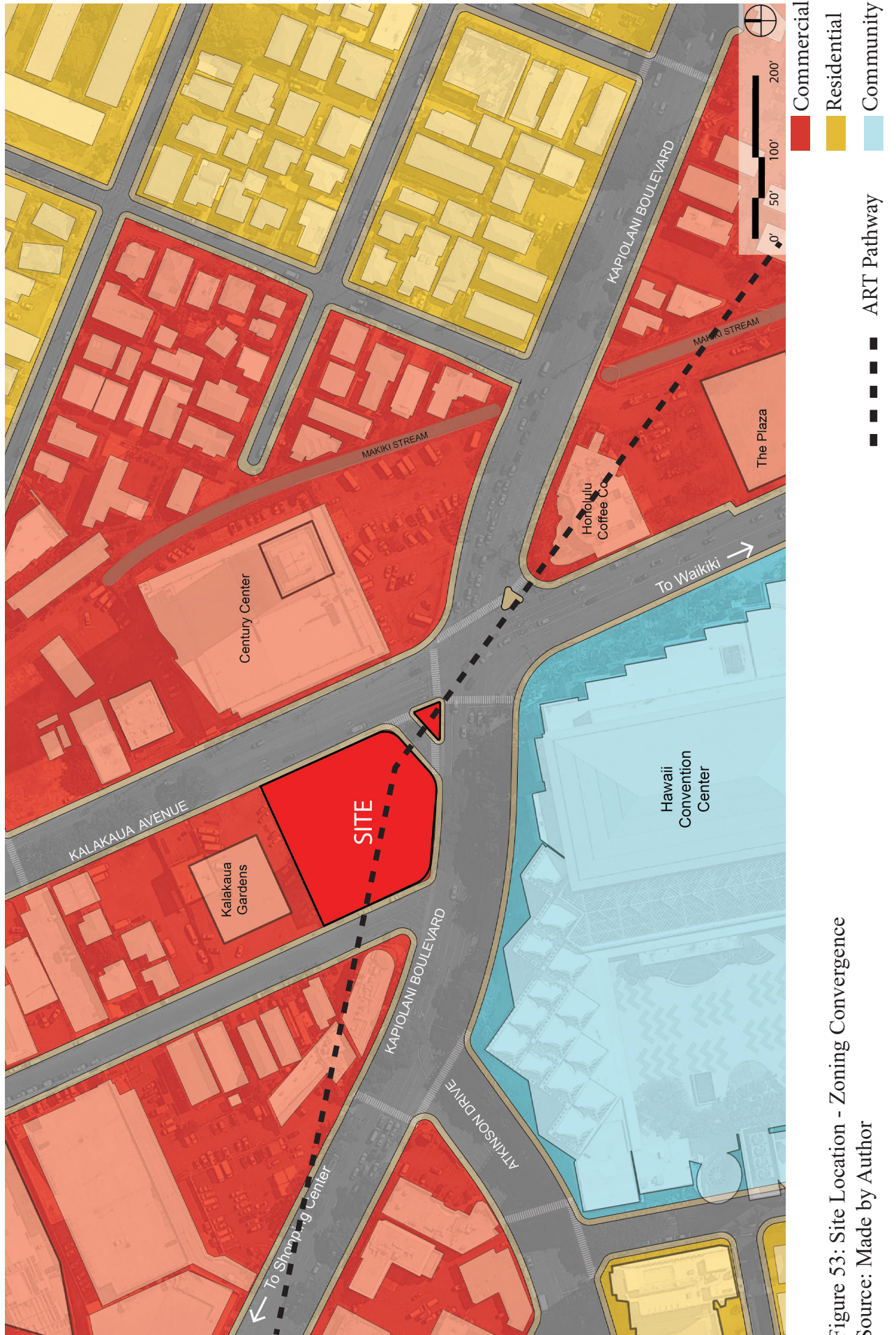


Figure 53: Site Location - Zoning Convergence

Source: Made by Author

residential community and the nearby commercial business owners. The following information outlines general projection statistics as well as characteristics of the population that surrounds the immediate site in 2021:

#### Demographics <sup>267</sup>

- Total Population within 0.25 mi: 7,262
- Median Age: 51.5 years
- Married (2016): 43.1%
- Industry Occupation: Services
- Median Income: \$44,943
- Households within 0.25 mi: 3,946
- Families within 0.25 mi: 1,616
- Owner Occupied Units: 1,567

#### Demands

- Public Transit Facilities
- Affordable Housing

#### Desires

- Safety and security
- Safe pedestrian and bicycling infrastructure
- Proximity to recreation areas
- Proximity to workplace
- Proximity to amenities

#### *Design Principles:*

Based on the characteristics and target market of the site, as well as the station research done in the previous chapter, three main design principles were identified and used to guide the basic ART station design layout:

1. Be People Oriented
  - Safe and secure facilities
  - Comfortable and high-quality spaces
  - Wide pathways for comfortable circulation
2. Maximize Transportation Efficiency
  - Hierarchy for circulation pathways

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<sup>267</sup> ESRI Community Profile - Hawaii Convention Center (Honolulu: ESRI, 2016), <https://bao.arcgis.com/esriBAO/index.html?portal=ccim.maps.arcgis.com#>.

- Intuitive Wayfinding
  - Multi-modal transportation elements
3. Promote Community Strength
- Supports a live, work, and play environment
  - Supports community place making
  - Environmental engagement

### *Transit*

Another main reason this site was chosen is because of its potential to provide a multi-modal transit hub, which would support safer and more direct access to other modes of transportation. Since one of the main goals of Oahu's public transit plan is to reduce dependence on vehicular transportation, an ART station would help to provide the necessary design features needed to attract drivers to a more appealing and convenient form of public transit.

Currently, Kapi'olani Boulevard has seven vehicular lanes, while Kalakaua has six vehicular lanes; an indication that the area was designed to primarily support automobiles, with little consideration given to pedestrians, bicyclists, and/or public transit riders. Pedestrian accessibility around this site is considered to be somewhat unsafe due to the convergence of numerous traffic lanes. However, a large number of pedestrians utilize these sidewalks when entering and exiting Waikīkī, though it can be difficult for them to access adjacent blocks. As of now, pedestrians must cross anywhere from five to seven traffic lanes along Kalakaua Avenue and Kapi'olani Boulevard. And, when pedestrians on the south-east block are traveling to the convention center, they are forced to use three crosswalks, and cross a total of 18 traffic lanes since there is no accessible crosswalk from the south east corner to the south west corner. With that being said, many pedestrians also choose to cross the street illegally, ultimately creating an even more dangerous situation for both themselves and the passing drivers. While integrating a crosswalk at this location may benefit pedestrians, it was noted that due to the high volume of vehicles traveling south—turning right from Kapi'olani Boulevard onto Kalakaua Avenue—adding a crosswalk at this location could actually create even heavier traffic at this intersection.<sup>268</sup>

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<sup>268</sup> SSFM International, *Honolulu Complete Streets Implementation Study Location Report*, Final (Honolulu: City and County of Honolulu, 2015), accessed April 2, 2017, 19, [https://www.honolulu.gov/rep/site/dts/dts\\_docs/150918\\_CSIS\\_Kalakaua\\_Draft\\_v2.pdf](https://www.honolulu.gov/rep/site/dts/dts_docs/150918_CSIS_Kalakaua_Draft_v2.pdf).

There is also a lack of bicycling infrastructure at this specific intersection. Currently, Kalakaua Avenue and Kapi‘olani Boulevard do not have bicycle lanes or street markings, forcing bicyclists to share traffic lanes with passing vehicles. There are also only two bicycle racks located in the immediate area; one rack is located in front of the Hawai‘i Convention Center, and the other is located in front of the Century Center. While future plans aim to provide a new cycling route along Kalakaua Avenue, temporary and long term bicycle storage has yet to be considered.

Because the area is already heavily utilized by public transit users, those users would only further support the proposed ART station at this location, as numerous bus routes already converge there. Currently, there is a total of five bus stops located within the immediate proximity of the station site: one stop is located on the northwest block, two are located on the northeast block, and two more are located on the southeast block. Combined, there are more than two thousand people boarding and alighting these bus stops on a daily basis.<sup>269</sup> While three of the five nearby stops provide very limited seating and shading for those people who are waiting for the bus, higher quality facilities could be implemented to provide a more comfortable experience for bus transit users, and thus attract more people to use public transit.

In terms of overall transportation, this site sees the convergence of all major modes of transportation. Furthermore, this area is already heavily utilized by buses, cars, bicyclists, and pedestrians, only further substantiating that this site has great potential to act as a multi-modal transportation hub. However, because the intersection currently favors transportation by vehicle, as seen by the high number of converging traffic lanes and lack of bicycle routes and crosswalk markings, there are also numerous accidents that occur, many which include pedestrians. The figure below illustrates the convergence multi-modal transit routes as well as the major locations of traffic accidents.

While the implementation of an ART transit station at this site would undoubtedly increase multi-modal diversity at the intersection, it would also provide the opportunity for updated design features aimed toward creating safer, multi-modal transitions.

To better support the principles of sustainable urban development and help transition residents to more sustainable modes of transportation, this mixed-use station will

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<sup>269</sup> Ibid., 13.



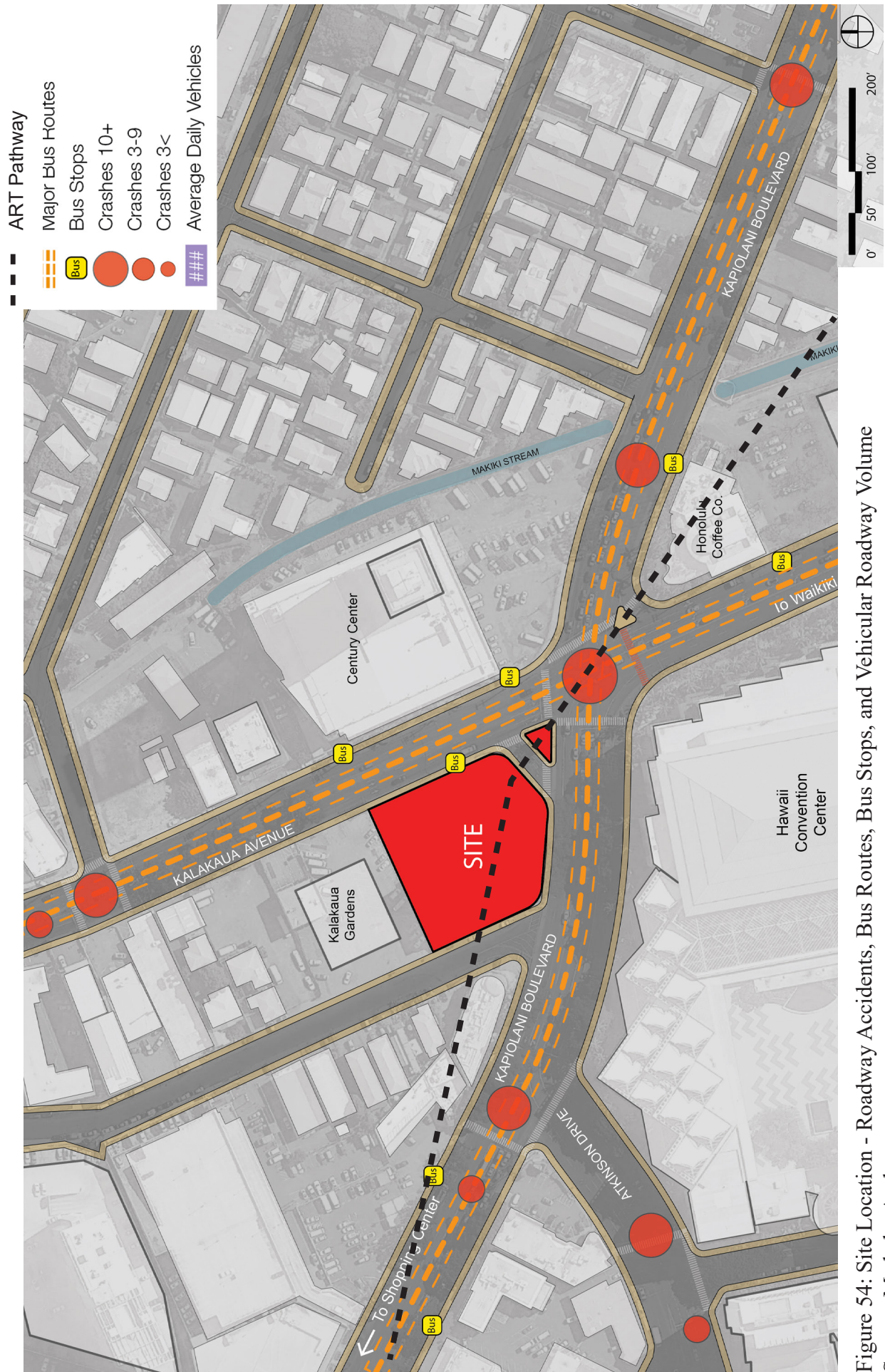


Figure 54: Site Location - Roadway Accidents, Bus Routes, Bus Stops, and Vehicular Roadway Volume

Source: Made by Author

not feature any form of long-term parking. Current zoning and design codes require new residential developments to offer some form of long term parking; however, the design of this project will alternatively focus on providing high-quality multi-modal elements to attract users towards bicycling, walking, and riding the gondola.

## 10.2 Process and Design Development

When first approaching the design of the station, the initial idea was to create a stand-alone, independent structure that would serve as nothing more than a transportation station. The station would provide the necessary design functions, with one type of user journey and without the addition of any amenities—commercial or workspace—in order to maintain the smallest possible footprint whilst providing a quick, efficient, and direct experience for passengers. However, because this research argues that the advantages of the aerial gondola can greatly increase other aspects of the community aside from efficient transportation, it only seems logical that the basic design of the station should adopt a bolder approach toward community integration in an attempt to incorporate aspects that would help to strengthen the area as a more lively, social, and economically active gateway area.

The next design approach was to construct the station directly above the roadway, allowing it to be built primarily over city-owned property, thus reducing the need for further land acquisition partnerships with private landowners and/or developers. Although at first this appeared to be beneficial, the limitations of this site would make it difficult to do so. Because of the high building density and angle of Kapi‘olani Boulevard, this particular station would need to be constructed directly above the center of the intersection. While this is possible, this particular intersection is one of the largest on the entire route; so when exploring structural layouts for its construction, columns either needed to be placed at strategic points in the middle of the intersection, or span 125 feet to 150 feet across it. Due to the convergence of numerous lanes, column footprints in the center of the intersection would be too disruptive to traffic flow, and for this reason, would need to be placed at each corner of the intersection. However, further exploration revealed that spanning this distance would either lead to very deep beams, or an extremely complex

suspension system, resulting in a much larger station. Furthermore, a structure that is overly large and positioned in the center of the intersection—just a few feet from the Honolulu Convention Center—would have a dominating and overwhelming presence; a characteristic counter to the initial design goals.

The final design approach was to construct the station on the original site—where Club Rock-Za! and the Micronesian Market currently exist—and to incorporate it into a mixed use high-rise. The decision to blend these typologies and incorporate the ART station into a new development building was based on existing public and private interest in reinvigorating the area as a means to support a livelier, mixed-use community, while simultaneously addressing the community's need for a more accessible, sustainable, and efficient public transit system. Though a stand-alone transit station would benefit the community, it would be a largely missed opportunity not to integrate the station into a mixed-use development: creating more opportunity for housing, community space, and commercial activity.

It is worth noting that other stations would not need to be designed on this large of a scale, as factors including route direction, existing building density, and geography determine where and how a station can be constructed. While an ART station could feasibly be constructed into a mixed-use high-rise, this design is based on the presumption that the developers on the project site would be willing to create the partnership necessary to do so. In theory, this could be a possibility if the city provided enough incentives, as doing so would result in benefits for the property owners.

Fortunately, as there is an increased interest in improving the urban quality of life by both policymakers and private citizens, it is becoming increasingly common for public private partnerships (PPP's)—a cooperative agreement between a private and government entity to invest in a single project.<sup>270</sup> For instance, The City and County of Honolulu is already exploring PPP's as an option to help to pay for the existing rail project. This would allow developers to build structures over the rail guideway, or integrate them into the stations themselves—a proposition very similar to this project.<sup>271</sup> Therefore, this proposal

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<sup>270</sup> Bryce Tupper, *Proposed Burnaby Mountain Gondola Transit Project*, 47.

<sup>271</sup> "City considering public-private partnerships to offset costs of rail," *Hawaii News Now*, June 14, 2016, accessed February 27, 2017, <http://www.hawaiinewsnow.com/story/32223156/city-considering-public-private-partnerships-to-offset-costs-of-rail-stations>.



is not unlikely, and may in fact be a probable, and necessary, development plan for ART.

### *Station Elements*

Based on the issues and characteristics identified in the site analysis, the basic elements that this transit station would require are identified below:

### *Essential Transit Elements*

1. Clear Station Entrance / Open Lobby
2. Waiting Areas
3. Restrooms
4. Ticketing
5. Circulation / Egress
6. Admin / Control Rooms
7. Boarding Platform
8. ART Guideway

#### Amenities

1. Restrooms
2. Commercial / Retail Space
3. Office Space

#### Design Elements Supporting Seamless Multi-modal Transfers

1. Wide pedestrian paths leading to the station entrance.
2. Temporary, long-term bicycle storage / bike share space.
3. Space for future bicycle share programs.
4. Room for Bicycles on the boarding platform and cabin.
5. Safe, comfortable, and highly visible seating for bus transit transfers located near the station entrance.
6. Safe and visible, vehicle-pedestrian drop-off points located near the station entrance.

### *Site Challenges:*

When beginning to design the station, several important factors needed to be taken into account. The main consideration, which determined the overall layout of the station design, was the placement of the guideway—the overhead mechanical equipment that detaches, slows, and changes the direction of the cabins. Aerial ropeway systems work most efficiently when they travel in direct pathways; therefore, the station guideway needed to be placed carefully in order to ensure that the route alignment would traverse

along Kapi‘olani Boulevard with a minimal turning angle. To reduce this angle, the route was directed to travel above a 26-foot, two-story, commercial building just west of the station site. The ART guideway was designed to sit 60 feet above ground level in order to maintain a substantial clearance above this building.

One of the challenges with placing the guideway was leaving enough space for boarding platforms, as well as circulation space on the makai side of guideway. Guideways are generally 30 to 40 feet across, and boarding platforms on either end of the guideway are typically 20 feet wide and 80 feet long. In order to reduce the route turning angle, the guideway was placed very carefully so as to allow enough room for these essential building elements. Placing the guideway too close to the edge of the property would result in stair and escalator circulation being placed on top of, or too near to the sidewalk.

As a turning station, the guideway needed to change angles in order to bank from Kapi‘olani Boulevard toward the Ala Wai Canal. The angle change required the guideway to cantilever beyond the makai edge of the property line, pass over the small roadway below, and over the pedestrian sidewalk island. Large angled column supports were placed to support the guideway above. Earlier station studies explored placing columns on the sidewalk island to support the guideway overhang. While this would undoubtedly support the guideway overhang, a more dramatic design approach was taken. Instead of static vertical support columns, large, truss-like concrete columns were used to emphasize the feeling of movement within and outside the station. The massive angled columns were designed to support the entire guideway along the property site and allow the guideway ends to cantilever above the sidewalk, providing a more dramatic experience as users circulated in and around the station.

### 10.3 Space Programming

Guideway placement at this high of an elevation resulted in ample space between the street level and the platform boarding level. This issue proved to be an even further challenge when integrating egress circulation pathways from the boarding platform to the street, thus needing to be carefully planned so as to allow quick and intuitive pedestrian

flow—an essential design requirement for all transit stations.

The high elevation of the guideway did, however, provide the opportunity for open floor space between the ground floor and boarding platform. Because pedestrians needed to circulate vertically in order to reach the boarding platform, this granted new opportunities for programmable space. Integrating these programs into the transit-user journey could potentially help attract more transit riders by providing them an enhanced traveling experience, while supporting economic exchange that could in turn help support transit system costs. The figure below illustrates the early visualization of the volumetric spaces within the station.

Though additional programming in a station can help to provide users with more convenient amenities, it is important that there remains a proper balance of commercial space, office space, and station functionality. If there are too many multi-programmed areas integrated into the station, it could potentially confuse and frustrate transit users, resulting in an unpleasant user experience. For this reason, the commercial space within this station was designated to the 1<sup>st</sup> and 2<sup>nd</sup> floors in the podium section of the project, leaving the 3<sup>rd</sup> floor for transit storage and administration, and the 4<sup>th</sup> floor for strictly boarding and alighting the gondola cabins. Office space on the podium floors of the project was separated, and provided its own entrance from the transportation and commercial section of the station.

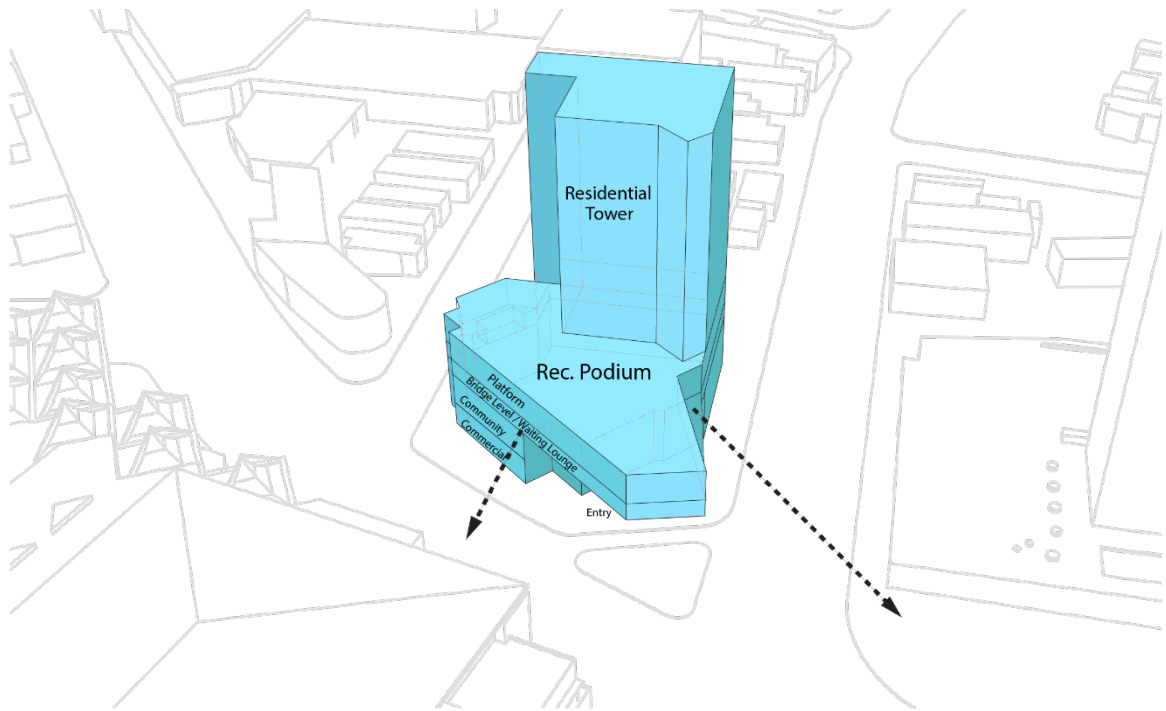


Figure 55: Massing and Program

Study. Source: Made by Author

## 10.4 Circulation

As mentioned in Chapter 9, it is important to maintain efficient user circulation paths on the exterior and interior of the station. In order to do so, egress pathways needed to be placed to ensure users could quickly and easily circulate in and out of the building. One of the major challenges of placing the circulation routes was to ensure there was an emergency stairwell at either end of the boarding platform on both sides of the guideway. This proved difficult, as the guideway placement, in conjunction the relatively small site parcel, limited flexible placement of these circulation elements. The diagram below illustrates the main flow of pedestrians upon entering the station.

To provide the transit user a quick method of traveling between the ground floor and the boarding platform, dual escalators on either side of the guideway were made. These escalators were placed in the middle of the platform where they would be most prominent and visible from the interior after entering the station, ensuring pedestrian circulation flows were both direct and intuitive. The escalators also provide disabled transit users access to

the boarding platform and station amenities. To further maintain intuitive circulation, the escalators and stairwell on the makai side of the guideway were designed to be visible from the exterior. Pedestrians on the exterior of the station would be able to see users on the interior, circulating through the stairwells and escalators.

To maintain circulation hierarchy between hurried and slow moving transit users, such as those interested in exploring the stations amenities, secondary circulation was created in the center of the station. Escalators were created to transition users between the commercial floors, stopping at the 3<sup>rd</sup> floor just below the boarding platform. Users wanting to transition to the boarding platform from the 2<sup>nd</sup> or 3<sup>rd</sup> floor could then take the central escalators to either side of the platform on the 4<sup>th</sup> floor.

This diagram shows a common area and/or lobby for waiting, activities and/or services—such as retail shops—and most importantly, a boarding platform where passengers can arrive and/or depart from the transit cabin. Though each station can vary in scale, design, and complexity, this user circulation pattern is nearly identical between stations.

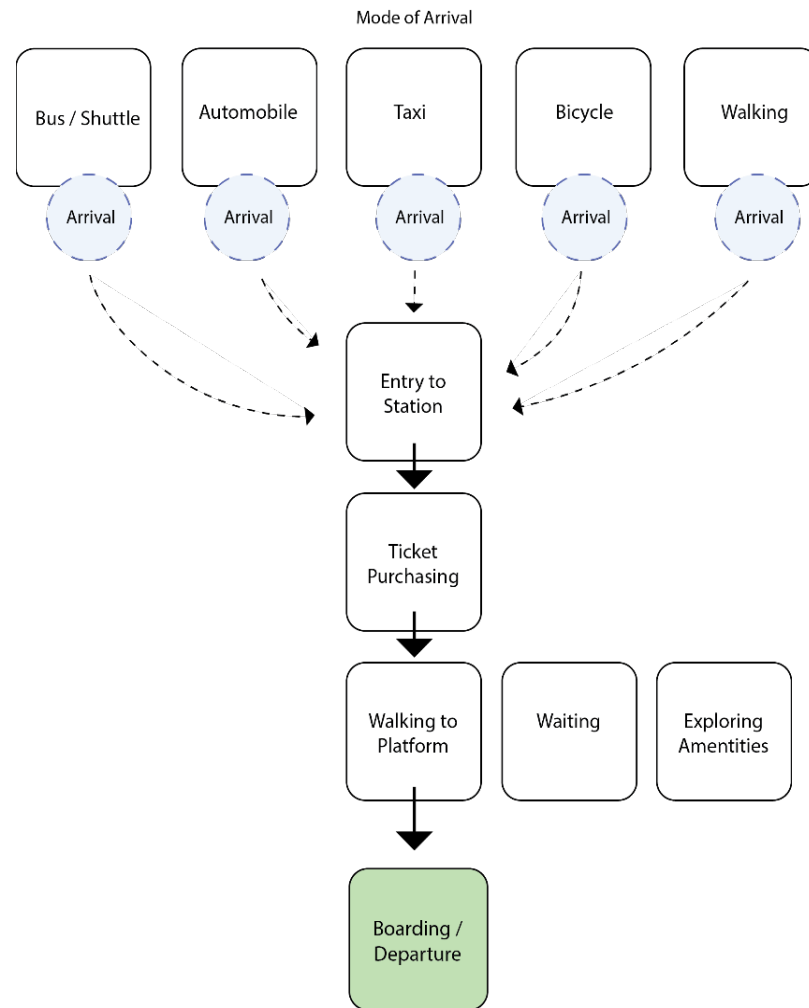


Figure 56: Transit Station User Route. Source: Made by Author

Based on the user route within this transit station, the required design elements can be identified. Upon arrival the user will move toward a clearly identified building entry point, where the user will then purchase a ticket for the transit system. After purchasing the ticket, the user will either explore the station’s commercial amenities; which may include a café, newsstand, and/or retail shops depending on the size of the station. Next, the user will make his/her way to the main boarding platform where he/she will wait for boarding of the transit cabin. Once boarded, the cabin will depart and user will finally arrive at, or near, his/her final destination.

By understanding this basic movement pattern at this transit station, the main elements can be identified and integrated into the design of the ART system. These elements include:

- Driveway
- Bicycle Storage
- Outdoor Public Waiting Areas
- Entrance
- Ticketing and Station Information
- Horizontal and Vertical Circulation
- Public Restrooms
- Commercial Spaces
- Lounges / Waiting Areas
- Queuing Spaces
- Passenger Platforms
- Transit System Guideway

## 10.5 Wayfinding

Another strategy to help improve intuitive circulation and lighting through the station, was to have glazing used on the exterior building envelope for the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> floors. This would help transit users to quickly identify where the main flows of vertical circulation were located, as well as allow a comfortable interior space that would let plenty of natural lighting into the station and prevent it from feeling too enclosed and/or removed from the surrounding urban environment. This feeling of transparency and increased visibility would provide users a sense of security, and potentially deter crime and graffiti on walls—a common problem in heavily utilized public buildings.

## 10.6 Sight Lines

Direct lines of a site are also integral to a station's performance. If direct sight lines between major elements—such as entry, ticketing, circulation, and/or boarding platforms—

are not maintained, circulation flows throughout the station become inefficient, and as a result, jeopardize the overall speed and efficiency of the entire ART transit system. In designing the station, direct visual sightlines were maintained between makai and mauka station entries to ensure passengers were cognizant of their location within the building, as well as their position on site. Locational awareness is critical for a transit users within the station because it allows them to not only understand their location within the building, but also their orientation within the context of the city, so they can intuitively board the correct gondola cabin that's traveling in direction of their desired destination. The Implementation of escalators between the 1<sup>st</sup> and 3<sup>rd</sup> floor also helped to create an opportunity for a central floor opening; allowing for visual views between the ground floor up to the 3<sup>rd</sup> floor to aid pedestrian wayfinding; and increasing the amount of light penetration between floors.

## 10.7 Linkages

Since one of major issues of this site is its lack of safe and efficient pedestrian infrastructure at ground level, integrating a transit station in an area that is also currently underdeveloped presents the opportunity to create new and interesting pedestrian linkages between future developments. Because high volumes of pedestrians will be entering and exiting the station, elevated pedestrian walkways could be provided, connecting the station boarding platform itself to the adjacent blocks. In this project, pathways extend outward from the boarding platform, and lead across the street to the convention center property, 1810 Kapi'olani Boulevard, and the Honolulu Coffee Experience property.

While these linkages are dependent on the participation of adjacent developers and property owners, the decision to participate in design integration would not only greatly increase foot traffic through their commercial development, but it would also improve convenience for the residents and visitors who would potentially reside in these new developments. Participation could also be incentivized by the city to allow development benefits such as Floor Area Ratio and zoning changes. The elevated pathways would most likely need to be constructed at later phases of the project once development in the area has progressed.



## 10.8 Multi-Modal Access

Because ART has the opportunity to strengthen the existing transportation network, one of the major design goals for this station was to integrate multi-modal design elements. One of the unique features of this site is that the pedestrian island at the corner of the property—currently the space between the property and the pedestrian sidewalk island—allows for vehicles traveling in the makai direction down Kalakaua Avenue to make a right turn onto Kapi‘olani Boulevard. This roadway provides the opportunity to place a comfortable and highly visible bus stop waiting area that is directly in front of the station’s entrance. Station users would also have a clear and direct sightline from the ticketing area inside the station, to the bus stop outside. The boarding platform and guideway also create a large overhang that would protect pedestrians from the elements.

Bicyclists are also one of the most important parts of the transportation network, because they support both pedestrian and public transit modes of circulation. Though this area lacks bicycle routes and lanes, they are both much more likely to become integrated in concurrence with a new transit station at this location. To support bicycle usage, three types of bicycle storage areas were implemented: short-term, long-term, and bike-share. First, short-term outdoor bicycle racks were strategically placed directly adjacent to both front and rear entrances to the station, providing storage for users that need to lock up their bicycle for a shorter period of time. Placing these in an area that is well lit and in plain sight helps to increase security and safety of the bicycles. However, for users who need to store their bicycle for a more prolonged period of time, a more secure, long-term storage space is provided to them just inside the station. Finally, space is allocated near the rear entry for bike-share in an effort to support a new bicycling infrastructure and a stronger transportation hierarchy in the future.

Additionally, as passengers are dropped off by family members, taxi cabs, and/or loved ones, it is necessary to have a designated kiss-and-ride area for these types of commuters. Fortunately, the acquisition of the small Piolani Shopping Center allows just enough room for a driveway, leading to another seating area, and vehicle waiting stalls on the opposite side of the main station entry. This designated kiss-and-ride area would be

positioned just next to the mauka entrance of the station, well within view from the ticketing area.

## 10.9 Cabin Design

Having an enhanced user travel experience is one of the aerial gondola's most intriguing aspects as an urban transportation system. The ability to travel while being suspended from a cable several stories above the ground, being able to view the city at a larger scale, is a unique experience that should be taken full advantage of. And, as gondola cabin is the ideal vehicle for such as experiential ride, the cabin's design elements should be given a good amount of consideration. Currently, most 3S and bi-cable systems—as well as all other public transit systems that are used in urban environments—are completely enclosed with transparent glazing on every side, with the exception of small operable vents to permit natural airflow. This is understandable, as safety, security, and protection from the elements are important. However, while this design element still allows a view to the outside, to even further open up the cabin to the surrounding outdoor elements, primarily by reducing the transparent boundary, would create a much more engaging commuter experience. As Oahu has some of the most spectacular natural landscape in the world—not to mention the incredible island weather—reducing the glazing barrier would allow passengers to fully engage their physiological senses. Just as a trolley is more fun to ride than a bus, and a convertible more exhilarating than a hardtop; the vivid color of the landscape, the sounds and smells of the city, and the feeling of the warm sun and cool breeze would offer the passenger a truly memorable commute. Therefore, while the cabins were designed to still maintain partial tinted glazing, they allow the passenger the ability to fully operate viewing capability from inside the cabin. Similar to a car window, the cabin glazing would be able to roll down to a comfortable and safe height, thus allowing for an unfiltered ART experience.

## 10.10 Station Design Analysis

This design project allows a basic conceptual glimpse of how one type of ART mid-station could potentially be integrated into Honolulu's urban landscape. While larger in scale, due to its integration into a high-rise development, this combined typology could create greater socio-economic opportunities. First, the additional programming supports the *community strengthening* principle, in that the commercial and office space provides transit with a work, live, and play environment—a principle that runs parallel to several of Oahu's community development plans. The area would also see a greater exchange of commerce due to commercial space coupled with the increased pedestrian volume. Being the mid-station east of Ala Moana, this station will see a high number of riders traveling primarily to and from work destinations into Waikīkī and UH Mānoa from West Oahu, as well as visitors traveling between tourist destinations such as the airport. And due to its location—being just across the street from the Hawai'i Convention Center—there would be larger volumes of people entering and exiting the station, especially during major events, which can bring in several thousands of additional daily visitors to the immediate area. The large pedestrian volumes coupled with the elevated pedestrian walkway linking each adjacent block, leaves little doubt that there would be a much livelier, and safer pedestrian presence in and around this intersection.

The multi-modal design features integrated into the station also serve as an example of how both efficient and quality features can help to ease the transition when switching to and from different modes of transportation. As effective urban circulation depends on the harmonious interaction between different transportation networks, providing the facilities for this to happen is an excellent way to encourage a more balanced and fluid network. The current auto-centric environment deters people from walking, bicycling, and/or using transit; but by providing an ART station that prioritizes alternate transportation modes, both residents and visitors would be much more willing to leave their private automobiles behind.

Overall, the livelier pedestrian environment, multi-modal facilities, overhead gondolas, and elevated pedestrian pathways provide a much stronger sense of activity around this intersection. Whereas the existing intersection provides little benefit to the

pedestrian, the new design creates a much stronger point of activity, helping to reinforce the area as a gateway into Waikīkī.



Figure 57: Station Site Plan - New Adjacent Development  
 Source: Made By Author

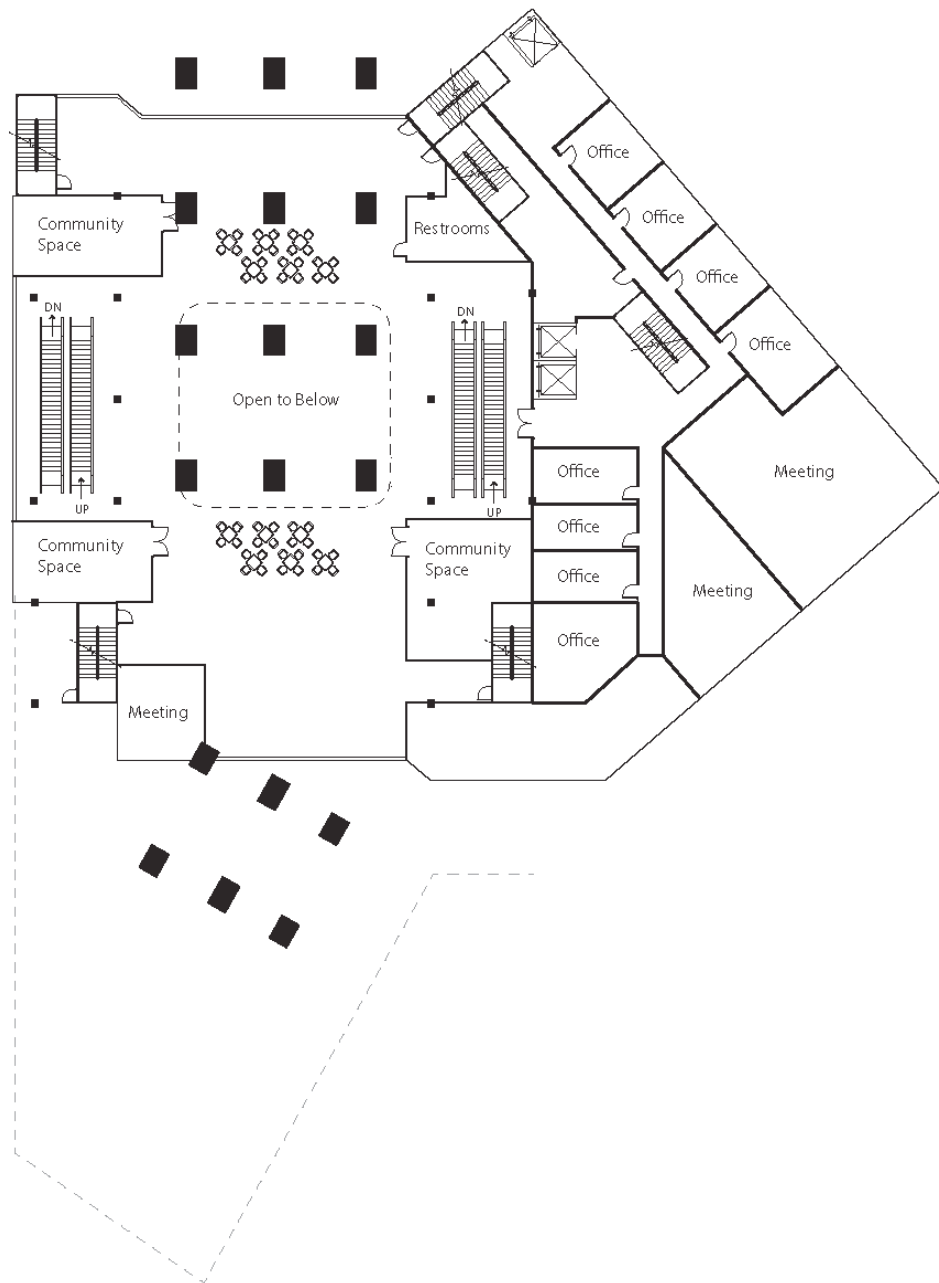




Figure 58: Station Ground Floor Site Plan  
Source: Made By Author



Figure 59: Ground Floor Plan - Ticketing, Information, and Commercial Space  
 Source: Made by Author



0' 10' 20' 40'



Figure 60: 2nd Floor - Community Gathering Space  
Source: Made By Author



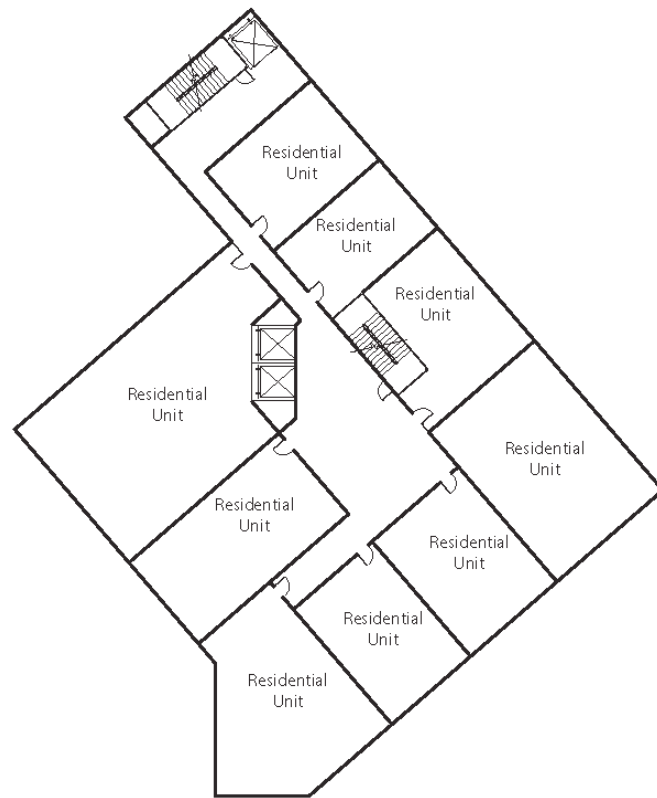




Figure 62: 4th Floor Plan - Boarding Platform Level  
Source: Made by Author



Figure 63: 5th Floor Plan - Residential Amenity Deck  
Source: Made by Author



0' 10' 20' 40'



Figure 64: 6th to 30th Floor Plan - Residential Apartments  
Source: Made by Author

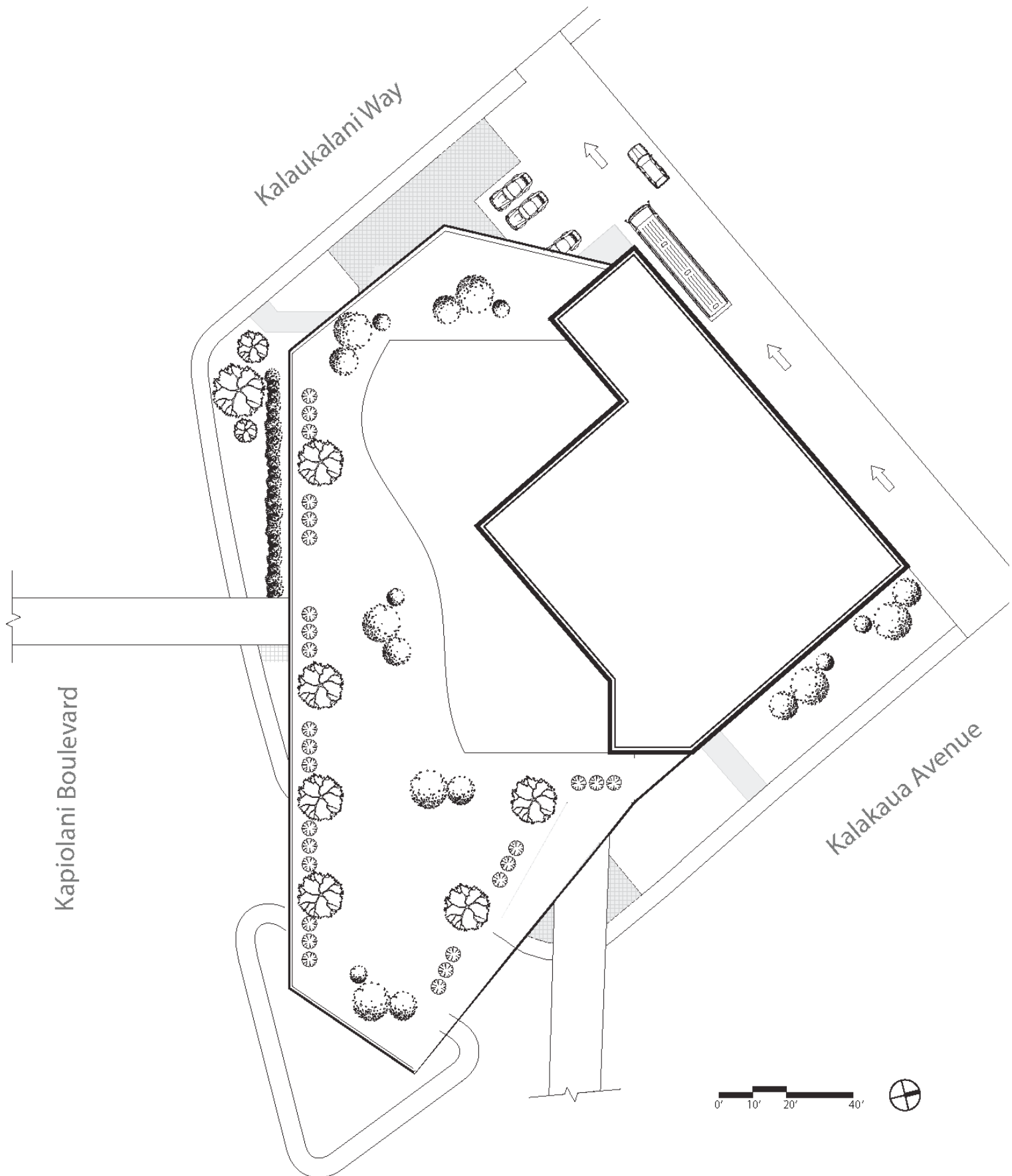


Figure 65: Roof Plan  
Source : Made by Author

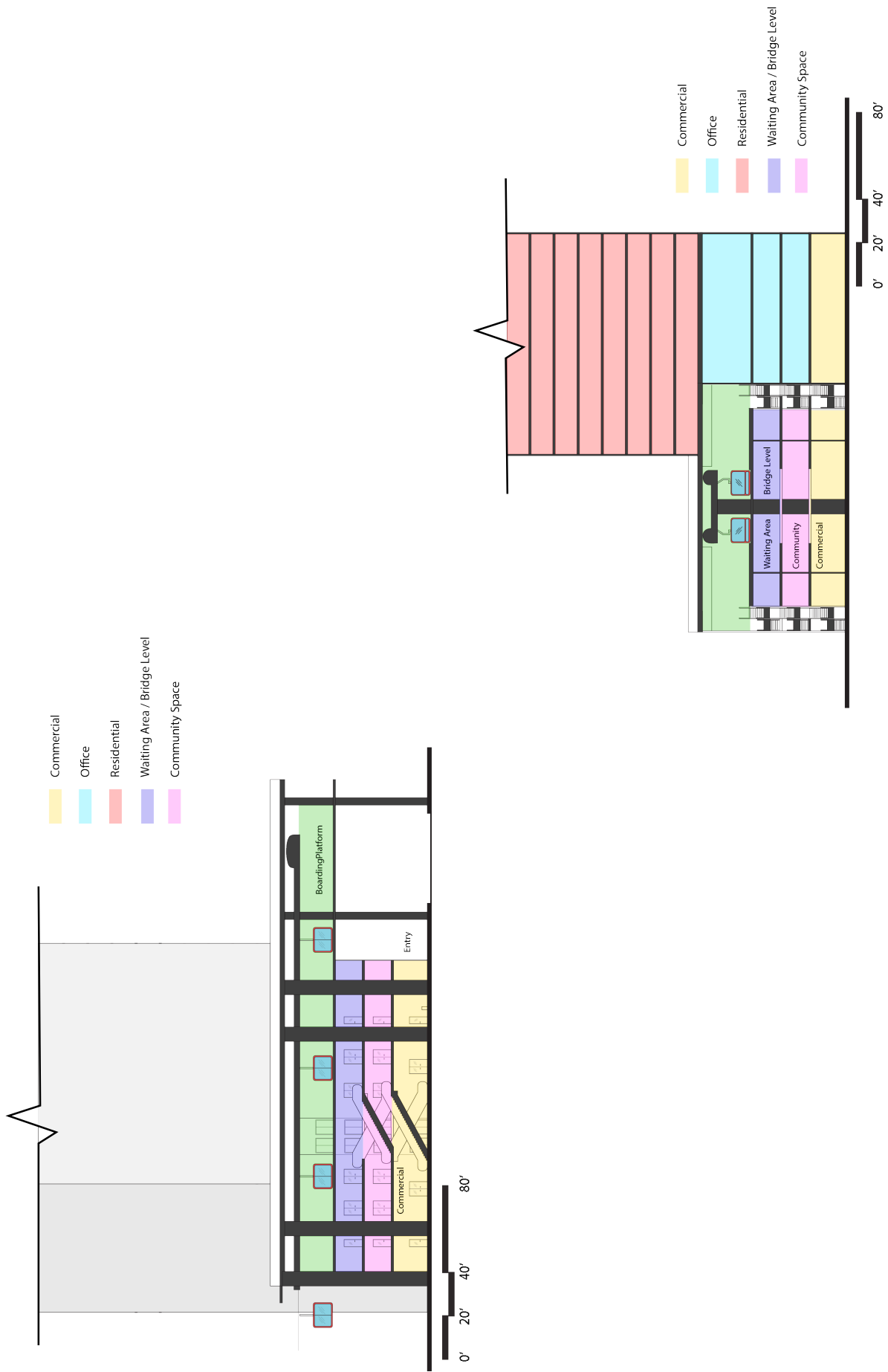


Figure 66: Station Section Cut and Program Diagram  
Source: Made by Author

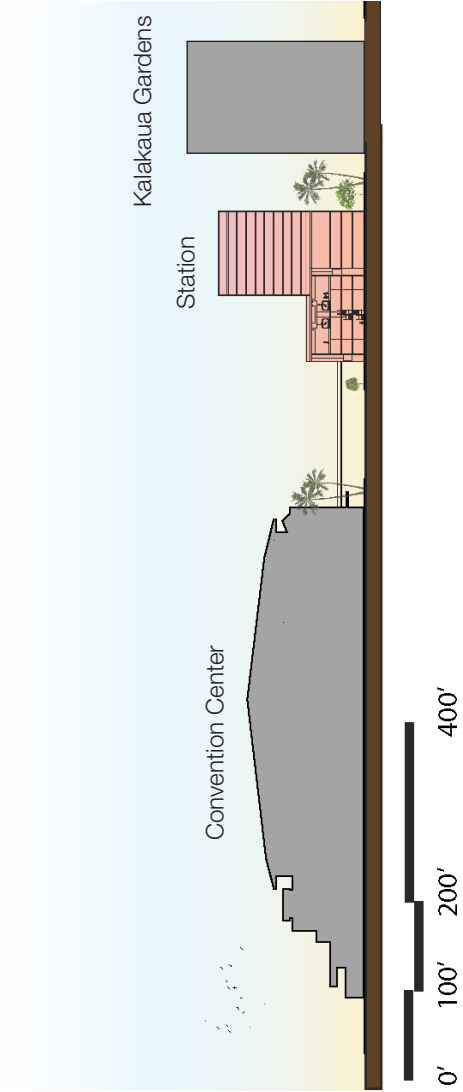
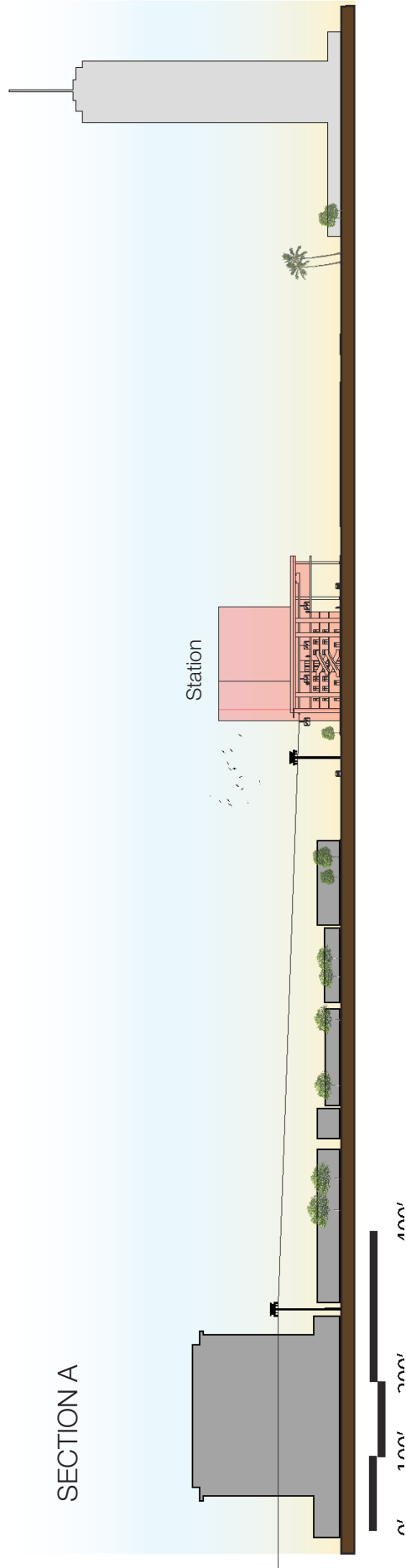


Figure 67: Station Site Section Diagram  
Source: Made by Author

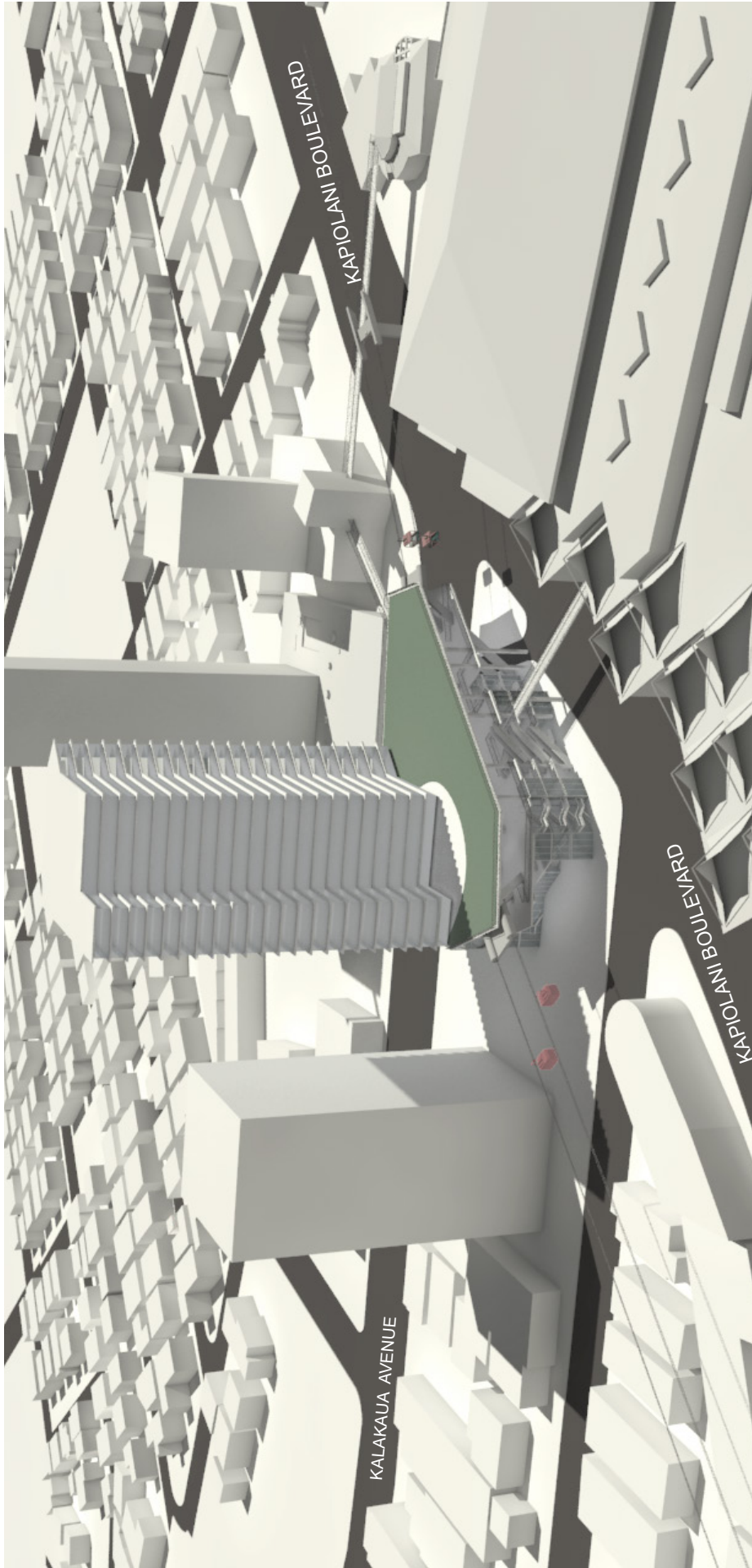


Figure 68: Aerial Station Perspective  
Source: Made by Author



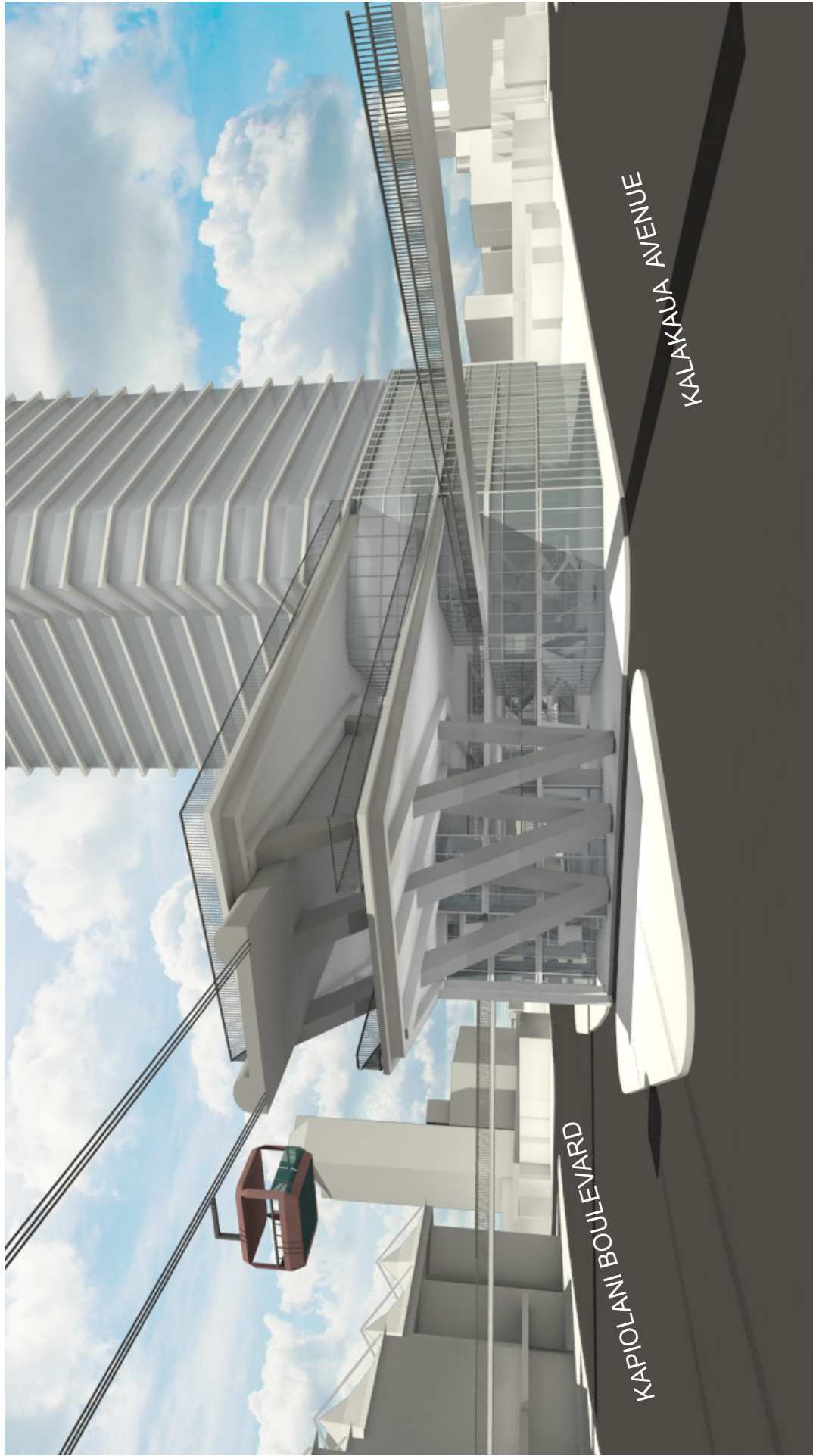


Figure 69: Entry Perspective  
Source: Made by Author

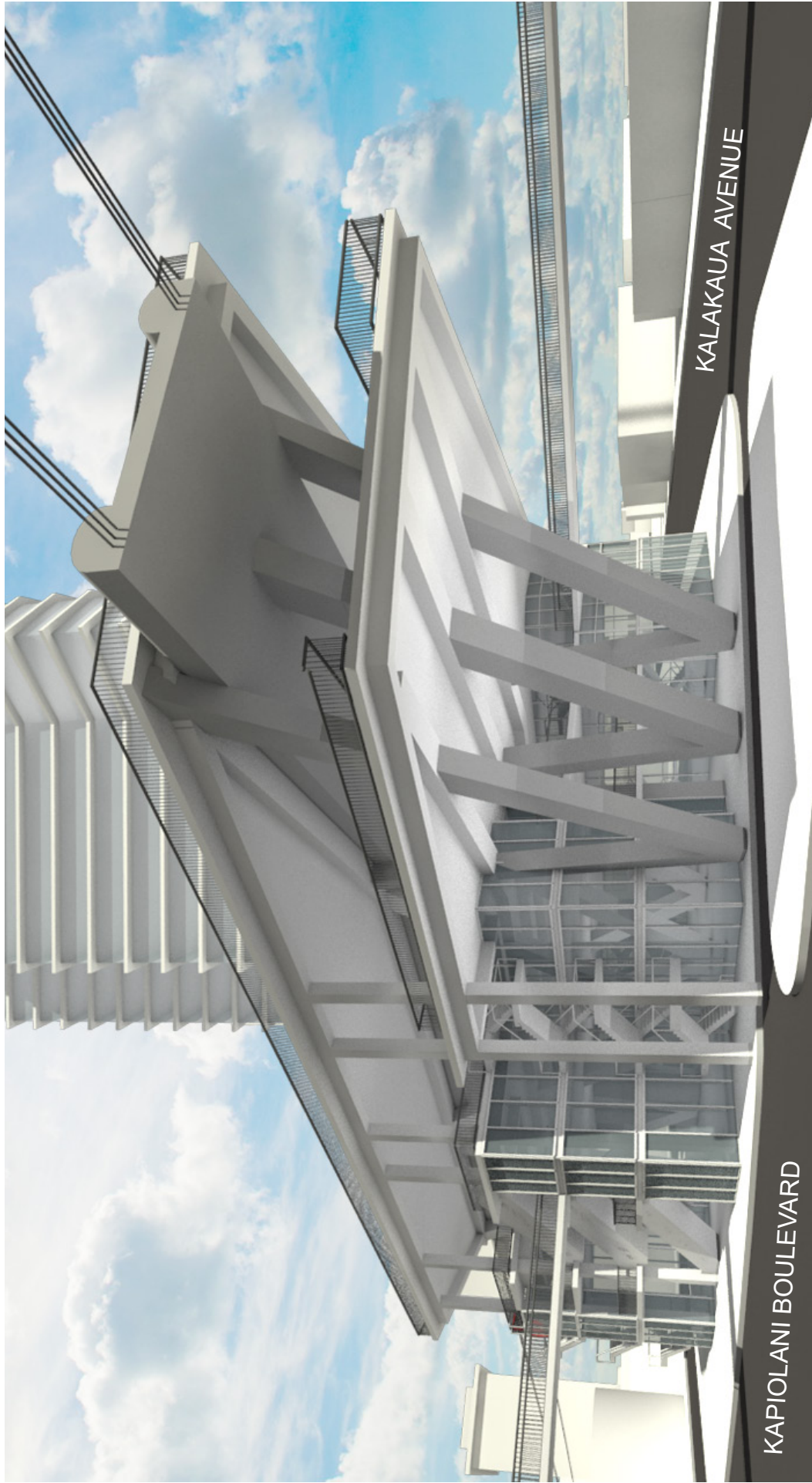


Figure 70: Station Entry Perspective  
Source: Made by Author



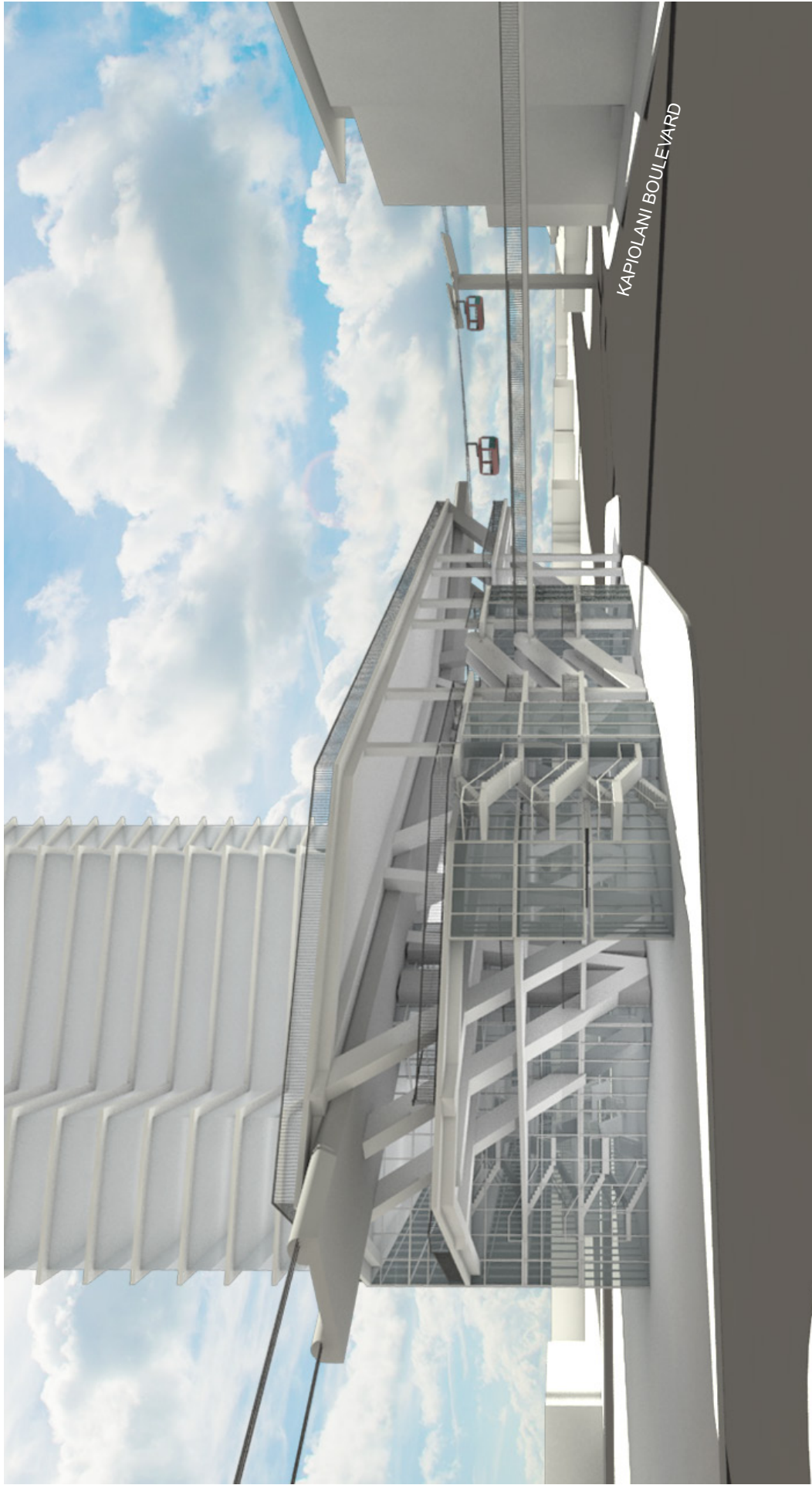


Figure 71: Rear Entry Perspective  
Source: Made By Author

## 11.0 Conclusion

Oahu's physical environment has seen tremendous change over the past decade, with development and population increasing far beyond what was once imagined. While this change is exciting to witness, people are experiencing the drawbacks of unplanned expansion. Transportation networks have not evolved with the urban fabric, and consequently, the fluidity of social and economic exchange has slowed. The initial rail project segment, planned to be completed in 2021, is an endeavor to increase these circulation flows and mitigate some of these negative symptoms. Planning, designing, and constructing the perfect transportation network, however, is a difficult task as Honolulu is an ever-evolving, complex mass of moving parts. Attempting to find the common thread between these parts, now, and in the unforeseeable future, needs thorough research and exploration. This project was originally undertaken to further explore new solutions that could potentially improve some of the issues that Oahu is currently experiencing. The ART system is proposed as a transportation alternative to rail; beyond the initial rail route that currently ends at Ala Moana Shopping Center. It is argued to provide a unique way of circulating people through Honolulu which can help to reinvigorate some of the important urban destinations left disconnected by the current rail route by providing a catalyst for some of Oahu's community development plans.

Waikīkī, UH Mānoa, and Kaimukī were identified in this research as important community neighborhoods that could substantially benefit from greater connectivity and fluidity with an improved transportation network. An analysis into Honolulu's transportation infrastructure and travel behavior patterns revealed that there is an immediate need for a solution. Lack of direct access, traffic congestion, decreasing bus speeds, and poor bicycle infrastructure are just a few of the issues that are lowering the quality of life for residents and visitors.

In comparison to the proposed rail extension beyond Ala Moana Shopping Center, an urban gondola would prove advantageous for several reasons. First and foremost, its nature as a cable-propelled, aerial system allows it to traverse above ground level. This advantage helps to reduce travel times between destinations as well as traverse over

challenging topography. As one of the most frustrating aspects of commuting in Honolulu is heavy traffic congestion, ART would be able to bypass traffic signals, pedestrian crosswalks, and high vehicular volumes.

ART would also be advantageous for Honolulu because it could address the access problem across the Ala Wai Canal between Waikīkī and the Moilili and Mānoa neighborhoods - as the system would be able to easily cross the canal.

Additionally, an aerial ropeway system in Honolulu would be advantageous because it is visually less imposing in comparison to the proposed elevated rail alternative. Instead of a heavy concrete guideway that has sequentially spaced columns, the aerial ropeway system will utilize half-inch diameter cables that traverse between its support towers. While towers can sometimes be required to reach greater heights, they can be placed at larger distances from one another, resulting in a transit system that still allows sunlight penetration onto the ground level.

Arguably its greatest advantage over other transportation modes is its ability to provide an enhanced traveling experience. Traveling peacefully, high above the city, is an experience that other transportation modes - aside from flying - simply cannot provide. The captivating transition from ground level immersion, to detached and curious observation, is not a daily occurrence and makes for a much more enjoyable commute. If the other numerous advantages of ART are not attractive enough to draw the everyday commuter away from their automobile, then the experiential aspect of the ride alone will help to fill the gondola cabin's seats. Furthermore, Oahu has one of the most picturesque landscapes in world; therefore, having expansive views of its surroundings while traveling to one's destination will further enhance this experience and increase ridership.

But even with its advantages, this research acknowledges that aerial ropeway transit is not yet a widely accepted form of urban transportation, and may be difficult for some to imagine in the city. The most common perception of ART is that it is a mountainous people mover; made to carry skiers and snowboarders up steep slopes into the rugged and snowy terrain; or a simplistic and novel attraction designed to show tourists a great view. While aerial gondolas can be both, the system has also been proven to be an effective mode of urban transportation and catalyst for social and economic change - in addition to being a fun way to travel to work. Cities in South America including, La Paz, Medellin, and

Caracas have shown that even basic forms of ART can significantly and positively change the way people move and engage with their communities. Other cities in the United States including Austin, Georgetown, and Chicago are also making efforts to explore ART as an option to help enrich the urban experience and transition people away from automobiles.

Though significant strides have been made in promoting aerial gondolas in the city, one of the most difficult challenges that it faces before it will be considered to be a viable system, is how to change the public's perception of this technology as a serious mode of transport. Just like every other transportation system, ART has its limitations; however, a proposal for Honolulu should not be immediately dismissed. In the essay titled "*Urban Gondolas, Aerial Ropeways, and Public Transportation: Past Mistakes and Future Strategies*" by Ryan O'Connor and Steven Dale, the authors reference a Harvard study in which proposals for new disruptive technologies in business corporations were too often dismissed because they did not immediately align with mainstream consumer interests, resulting in unfortunate missed opportunities for advancement and growth within several industries. O'Connor and Dale argue that ART is, in a sense, a disruptive technology to the urban transportation network.<sup>272</sup> While there is inherent risk to adopting new strategies in urban planning, this constantly advancing system has already proven itself to be effective in other urban environments. Community members and policy makers, therefore, should not be so quick to dismiss this option, and instead consider the unique benefits it could provide Honolulu, as it has the potential to fundamentally change how residents and visitors move through and experience the city.

The urban community needs to understand that there are transit options beyond what is traditionally seen in cities across the United States; therefore, a major step in ART's implementation in Hawai'i is educating the public about its advantages and successes in other cities in order to break free from the perception that this system is just a novel tourist attraction. This can be achieved through further research into the topic, especially as more cities adopt the system. The exploration into this new urban method of transportation through literature reviews, transportation analysis, and case studies have answered the

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<sup>272</sup> Ryan O'Connor and Steven Dale, *Urban Gondolas, Aerial Ropeways, And Public Transportation: Past Mistakes And Future Strategies*. (Rio de Janeiro: OITAF Congress, 2012), <http://www.oitaf.org/Kongress%202011/Referate/O'Connor%20-%20Dale%2001-2012.pdf>.

initial questions set forth at the beginning of this research, in an effort to do just that. Though this system is quickly gaining interest in cities around the world, more time will be needed to explore this method of transportation in Hawai'i. After all – it has the potential to become a unique and beneficial addition to, not only Honolulu's transportation network, but to the community's pride, sense of place, and standing as a leader in sustainable and progressive practices. In the end, solutions to some of the most challenging urban issues can be the most surprising and unexpected. It is possible; therefore, that if we look beyond conventional urban practices and allow ourselves to think unconventionally, we may find the disruptive solution that we've been looking for.

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